263175

JPRS 81367

26 July 1982

19980922 090

USSR Report

ELECTRONICS AND ELECTRICAL ENGINEERING

No. 93

12
169
AØ8

NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

PROCUREMENT OF PUBLICATIONS

JPRS publications may be ordered from the National Technical Information Service (NTIS), Springfield, Virginia 22161. In ordering, it is recommended that the JPRS number, title, date and author, if applicable, of publication be cited.

Current JPRS publications are announced in Government Reports Announcements issued semimonthly by the NTIS, and are listed in the Monthly Catalog of U.S. Government Publications issued by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Correspondence pertaining to matters other than procurement may be addressed to Joint Publications Research Service, 1000 North Glebe Road, Arlington, Virginia 22201.

NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

PROCUREMENT OF PUBLICATIONS

JPRS publications may be ordered from the National Technical Information Service (NTIS), Springfield, Virginia 22161. In ordering, it is recommended that the JPRS number, title, date and author, if applicable, of publication be cited.

Current JPRS publications are announced in Government Reports Announcements issued semimonthly by the NTIS, and are listed in the Monthly Catalog of U.S. Government Publications issued by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Correspondence pertaining to matters other than procurement may be addressed to Joint Publications Research Service, 1000 North Glebe Road, Arlington, Virginia 22201.

USSR REPORT

ELECTRONICS AND ELECTRICAL ENGINEERING

No. 93

CONTENTS

BROADCASTING, CONSUMER ELECTRONICS

COMPUTERS

CONTROL SYSTEMS

ELECTRICAL INSULATION

ELECTRON DEVICES

INDUSTRIAL ELECTRONICS & CONTROL INSTRUMENTATION

INSTRUMENTATION & MEASUREMENTS

MAGNETICS

MICROWAVE THEORY & TECHNIQUES

METHODS OF SIGNAL PROCESSING IN SYNTHETIC-APERTURE RADAR FOR SOLUTION OF
NATIONAL ECONOMIC PROBLEMS (REVIEW)

SHTEYNSHLEYGER, V. B., YERKIN, A. N., LIFANOV, P. S., MISEZHNIKOV, G. S.
and YANOVICH, A. V.

[Abstract] Basic operating principles of synthetic-aperture high-resolution
radar are summarized, assuming a transmitter signal with periodic pulse
modulation and an echo signal converted by the phase detector in the receiver
to one with linear frequency modulation. Such radar is becoming increasingly
useful in exploration of the earth crust and the seabed from spacecraft, in
search of natural resources and for monitoring of the environment. The
capabilities of such radar were first realized through optical processing of
signals in real time. Improvements in this method include the use of a
telescope and a Pockels Readout Optical Modulator. Recording of primary
data is still a problem, the disadvantage of photographic film being the time
delay caused by the finite duration of photochemical processes. The disad-
vantages of variable-thickness thermoplastic films are low sensitivity,
criticality of development by heating, and narrow dynamic range. A better
method of signal processing is with cathode-ray memory tubes ("lithocon"
with silicon target and SiO_2 coating), preferably frame-by-frame rather than
quasi-continuous mode because of less stringent requirements on the CRO per-
formance characteristics and on the width of the signal spectrum. This
analog device cannot deliver the necessary precision at high focusing ratios.
The best method so far is digital or descrete-analog signal processing, pre-
ferably with elimination of redundancy and a low readout repetition rate.
Most efficient here is partial data compression, for which several algorithms
are available: time scale conversion, frame-by-frame processing, and filtra-
tion of Doppler frequencies. Figures 9; references 34: 18 Russian,
16 Western.
[199-2415]

ADM-2.5 HIGH PERFORMANCE RADIO RELAY ANTENNAS

[Article by Yu. A. Yerukhimovich, candidate of technical sciences, senior scientific worker at NIIR: "Set of radio relay antennas"]

[Text] The AMD-2.5 antenna belongs to a series of high performance axial symmetric twin reflector antennas for radio relay communications which have been developed by a collective of workers at the USSR Ministry of Communications State Scientific Research by Institute of Radio. These antennas are now in series production. The antennas in this series have radiating aperture diameters of from 1 to 5 m and are designated, respectively, as follows: ADE-1; AMD-1.75; AMD-2.5; ADE-3.5; ADE-5. All of these antennas are based on a new plan with a displaced focal axis of the parabolic generatrix. A number of USSR patents are used in their construction (for example, No 237 934, 316 357, 280 574, 645 484, et al.), which made it possible to provide good electrical parameters and design characteristics.

A number of new technological processes and materials are used in producing the antennas: electroforming of thin layers of metal followed by strengthening with plastic foam; a radio transparent system used to fasten the secondary reflector on the horn, which also seals the feeder; pressure casting; ordinary and metallized fiberglass, etc. Under ordinary conditions, the antennas do not require external protection by randomes or covers. The removable protective enclosure is provided for especially difficult climatic zones.

The operating ranges of the antennas cover the entire span of frequencies used for radio relay communications — from 2 to 12 GHz. The antennas have a high coefficient of surface utilization — $K_{su} \leq 0.7$, SWR$\leq$1.06, protective action of at least —65 dB, and lowest level of cross-polarization field at least —30 dB.

The directivity patterns satisfy the specifications of the SSIR reference patterns for high performance antennas. Operation is possible on two respectively per-pendicular linear or two rotating field polarizations and in two adjacent radio frequency bands simultaneously. The AMD-2.5 antenna (cf. figure) is designed primarily to operate in the "Oblast'" communications system in the 8 GHz range.
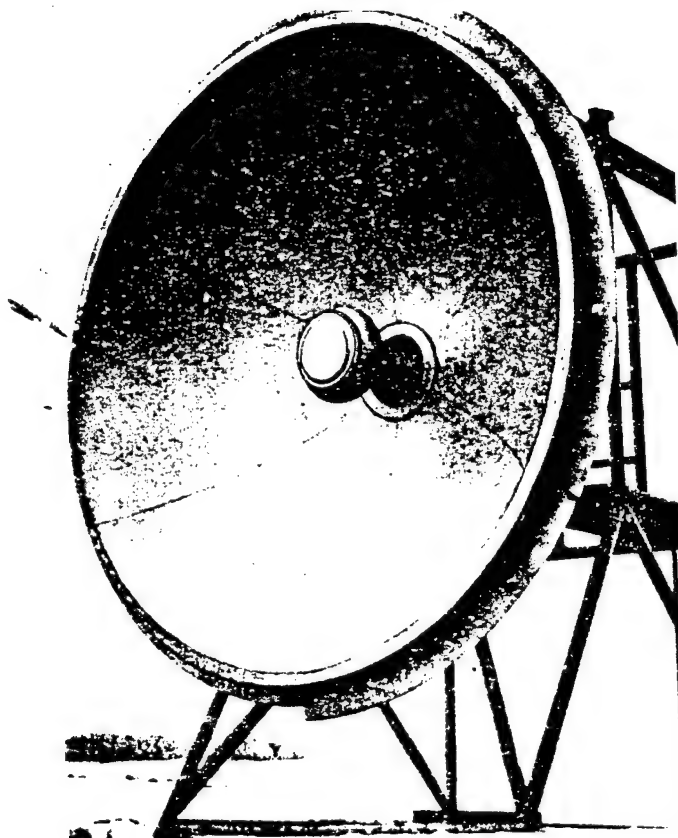
AMD-2.5 radio relay antenna.

Of all other types of antennas with displaced focal axis of the ADE and AMD type, these have, for the same gain, the smallest size and weight, greatest adaptability to manufacture and production economy, as well as good operating characteristics.

The AMD-2.5 and ADE-5 antennas have been given the State quality seal. The external appearance of the antenna is protected by industrial patents No 7115 and 10681.

SCATTERING OF ELECTROMAGNETIC WAVE IN SLOT IN DIELECTRIC LAYER ON IDEALLY
CONDUCTING SURFACE

VASIL'YEV, Ye. N. and FEDORENKO, A. I.

[Abstract] Individual wafers cemented to an ideally conducting substrate are
often used as absorbing coverings. Gaps inevitably appear between these
wafers and they act as scattering centers. A model problem is discussed for
the purpose of studying the diffraction characteristics of scattering centers
of this type. In a layer of dielectric of given thickness there is a slot
which is filled with a dielectric with specific electrical and magnetic
parameters. It is assumed that the structure is symmetric relative to the
$x = 0$ plane and that the shape of the edge of the slot and of the filling
are arbitrary. A plane electromagnetic wave with E- or H-polarization strikes
at a specific angle to the X axis perpendicular to the direction of the slot.
The problem is to find the scattered field. By means of a mirror transforma-
tion the problem is reduced to the problem of the diffraction of two waves
in a layer of doubled thickness. A system of integral equations is derived
for the equivalent electric and magnetic current densities determined at
specific surfaces. It is demonstrated that with a low coefficient of re-
flection from the dielectric layer the secondary field is determined basically
by reflection from the uncovered portion of the substrate and its level is
comparable with the level of the scattering field in an ideally conducting
strip of the same width as the slot, at least in the sector of angles far
from grazing angles. It is shown that with $\Delta < \lambda/2$, where Δ is the size of
the slot and λ is the wavelength, the level of the scattered field is lower
with E-polarization than with H-polarization and that this difference becomes
smaller with an increase in Δ. The addition of a filling has a substantial
influence on the change in the slot's effective scattering surfaces if the
density of the dielectric from which the filling is made is considerably
greater than the density of the dielectric layer. The calculation results
presented make it possible to evaluate the scattering properties of the
structure studied with various dimensions of the slot and various parameters
of the dielectric layer. Figures 3; references 3: 2 Russian, 1 Western.
[218-8831]

4

PERTURBATION OF IONOSPHERIC F-LAYER BY INTENSE RADIO WAVE

KOLESNIK, A. G., Siberian Physico-Technical Institute at Tomsk University

[Abstract] The behavior of the ionospheric F-layer in the temperate zone
upon heating by an intense radio wave is analyzed on the basis of the mathe-
mathical model of transients in an ionospheric plasma. The corresponding
equations describe the dynamics of and the energy relations in three
plasma components: charged (NO^+), neutral (N_2, O_2) and metastable. These
equations have been solved by the method of finite differences with matrix
elimination and Newton iteration, for appropriate heliogeophysical condi-
tions typical of the temperate zone. The thus calculated transients of
NO^+ concentration and electron concentration as well as of vibrational
temperature and electron temperature reveal the trend of buildup after
turn-on and then complete relaxation to ambient levels after turn-off of
the pumping radio wave. The relaxation of electron concentration in the
F-layer is sufficiently slow to let the F-layer "memorize" the event.
The author thanks M. N. Vlasov for helpful and stimulating discussions.
Figures 2; references 14: 7 Russian, 7 Western.
[201-2415]

EXTRACTION OF RADIO WAVES FROM IONOSPHERIC WAVEGUIDES BY MECHANISM OF BEAM
SWINGING

AFANAS'YEV, N. T., SVISTUNOV, K. V. and TININ, M. V., Irkutsk State
University

[Abstract] The mechanism of energy extraction from ionospheric waveguides,
particularly between E and F layers, through various large-scale inhomo-
geneities along the path of propagating decameter radio waves is analyzed
on the basis of a resonance model. Resonant swinging of radio beams is
described approximately by a second-degree two-dimensional differential
equation in Cartesian coordinates with appropriate initial and boundary
conditions. A solution of this equation, by the method of averaging or by
the method used for solving the similar Mathieu equation, yields the ampli-
tude of the swinging trajectory and the conditions of parametric resonance.
Analytical results compare fairly accurately with results of numerical
solution for 1000 and 2000 km long distance assuming various initial beam
"phases." Figures 2; references: 12 Russian.
[201-2415]

RESULTS OF ANNUAL-CYCLE MEASUREMENTS OF VERTICAL ATTENUATION AT 8.2 mm
WAVELENGTH IN TERRESTRIAL ATMOSPHERE BASED ON INTRINSIC RADIATION

BABKIN, Yu. S., SUKHONIN, Ye. V. and CHERNYSHEV, V. I.

[Abstract] Measurements based on intrinsic atmospheric radiation in the
central European part of the Soviet Union have yielded annual and seasonal
statistical distributions of total vertical attenuation, at the 8.2 mm
wavelength, caused by hydrometeorological formations in that region.
Measurements were made by the radiometric method in the Zimenki village
(Gor'kovskaya oblast) for 5500 h during the period from 4 July 1978 to
4 July 1979. The equipment included an h-f stage in the focal module of
an RT-25x2 radio telescope, with a horn antenna having a 54x540 mm^2
rectangular cross section and located at a distance of 6 m from a rotatable
2x2 m^2 plane metallic reflector of sky radiation. The superheterodyne-
type radiometer with modulation was capable of measuring a noise signal in
the 400 MHz band along both i-f main and reflector channels. The data on
vertical attenuation by stratus and cumulus clouds as well as by rain drops
of all except very small sizes have been processed and can be further
processed, by application of the law of cosines, to yield statistics on
oblique attenuation in "ground - satellite (geostationary)" communication
lines. The data reveal a maximum attenuation of up to 25 dB in summer and
a minimum attenuation up to 2 dB in winter. The authors thank A. G. Kislyak,
M. A. Kolosov and A. V. Sokolov for steady interest and helpful comments.
Figures 3; references 17: 6 Russian, 11 Western.
[199-2415]

PROPAGATION OF SHORT RADIO WAVES THROUGH MAGNETOSPHERIC CHANNELS

YERUKHIMOV, L. M., KROTOVA, Z. N. and URYADOV, V. P., Scientific Research
Institute of Radiophysics

[Abstract] Transequatorial propagation of short and ultrashort radio waves
through "ducts" between oblong inhomogeneities in the geomagnetic field is
analyzed on the basis of the wave equation in MacIlvain coordinates. A
computer-aided numerical solution indicates the feasibility of channeling
decameter and meter waves between geomagnetic latitudes not farther than
30°, if the transverse gradient of electron concentration is moderate. The
results also yield the relation between "duct" parameters and the passband.
Figures 2; references 13: 7 Russian, 6 Western.
[201-2415]

COMPENSATION OF PHASE DISTORTIONS IN SPACED APERTURES BY MEANS OF BROADBAND SIGNAL

ZHULINA, Yu. V.

[Abstract] The problem of observing K bright objects in space by means of
N transmitters and M receivers is considered when each transmitter probes an
object independently. An algorithm of simultaneous estimation of coordinates
as well as amplitudes and phase distortions is constructed according to the
maximum-likelihood principle and with use of a broadband probing signal
having a resolution interval smaller than the distance between individual
objects. Phase distortions are assumed to occur only in the atmosphere
and in the equipment. The reflecting surfaces of objects are assumed to be
completely independent and unknown, determined by their diffraction patterns.
The error of measurements is evaluated by averaging the matrix of second
derivatives of the logarithm of the likelihood function with respect to the
measured parameters at their true values. The feasibility of accurate
measurement of relative coordinates is established on the basis, even with
phase distortions in the signal. The constraints are also established for
accurate measurement, by the coherent method with phase compensation, of
absolute coordinates. References: 2 Russian.
[199-2415]

CORRELATION CHARACTERISTICS OF OVERSHOOT FLUX INTENSITY IN ATMOSPHERIC RADIO INTERFERENCE

DOBRYAK, D. S. and PETROVA, L. G.

[Abstract] The characteristic functional of instantaneous overshoot flux
intensity in atmospheric radio interference caused by a thunderstorm is
obtained for the very-low-frequency range. After territorial distribution
and variation in time have been considered, statistical relations are
established between intensities at various instants of time at various
levels of receiver threshold sensitivity. The correlation coefficient is
calculated accordingly, as a function of the distance between receivers and
as a function of the relative difference between mean intensities. The
correlation time of an overshoot flux intensity is also calculated, as a
function of the mean intensity. An overshoot flux is regarded as a random

field and these correlation characteristics render a rather complete statistical description of its intensity. Other characteristics of atmospheric radio interference such as its psectral density can be obtained analogously. Figures 4; references 4: 3 Russian, 1 Western.
[199-2415]

MEASUREMENT OF FREQUENCY AND ANGLE OF ARRIVAL OF SIGNALS RECEIVED BY ANTENNA ARRAY AGAINST BACKGROUND OF NOISE IN ACOUSTO-OPTOELECTRONIC PROCESSING

NAKHMANSON, G. S,

[Abstract] Acousto-optoelectronic processors represent multichannel ultrasonic light modulators combined with optoelectronic systems making it possible to process the signals of antenna arrays in real time. A discussion is presented of the accuracy of measuring the angle of arrival and frequency of narrowband signals received by a linear antenna array against a background of external noise and the intrinsic noise of the optoelectronic system, taking into account the nonidentity of the amplitude-phase characteristics of the input channels of the acousto-optoelectronic processor (AOEP). The formula is given for the vector of the received signals when the receiving antenna is represented as a linear equidistant array with $2N + 1$ receiving elements arranged at a distance of b from one another. Electrical signals from the receiving elements of the antenna enter input channels and the input of a $(2N + 1)$-channel ultrasonic light modulator. The electrical signals act on piezoelectric transducers and excite acoustic signals, which, being propagated in the acousto-optic interaction medium of the working channels of the ultrasonic light modulator at a certain speed, cause a change in the refraction coefficient of the medium according to a specific rule. An equation is presented for the distribution of the intensity of the light field in the outlet focal plane of the integrating lens as a function of spatial frequencies, $I(u, \theta, t)$, and equations are presented for the statistical characteristics of $I(u, \theta, t)$, its mean value and the correlation function. The electrical signal from the output of a photodetector enters the input of the electronic circuit of the optoelectronic system, which contains in each channel linear amplifiers and threshold devices whose output signals enter the input of a resolver. The resolver makes an estimate of the frequency and angle of arrival of the signal being analyzed. The statistical characteristics are given for estimates formed, of the frequency and angle of arrival of a signal. These statistical characteristics are determined by the power level of the external noise and intrinsic noise of the optoelectronic system. Worsening of these characteristics is

dependent on the choice of the threshold level at which measurements are made and on the degree of the difference in the amplitude-phase characteristics of the AOEP's input channels. Preamplifiers for the AOEP's input channels must be chosen which have low noise characteristics and identical amplitude-phase characteristics. Figures 4; references: 6 Russian. [218-8831]

INFORMATION CAPACITY OF MULTICHANNEL ACOUSTOOPTIC MODULATORS

BANNOV, V. Ya., GUSEV, V. A. and KIPPER, R. I.

[Abstract] The information capacity of multichannel acoustooptic modulator (MAOM's) is the number of resolvable light spots formed by the optical system in the output plane. The number of resolvable light spots for the X coordinate equals the number of channels and depends on the height of the acoustooptic conductor, the width of the electrodes of the piezoelectric transducer and the gap between these electrodes. The number of resolvable light spots for the Y coordinate is determined by the width of the transmission band of each channel and by the duration of the introduced signal, which is in turn expressed in terms of the aperture of the incident light and the velocity of the acoustic wave. Equations are presented which express these relationships and on their basis and on the basis of further analysis of the terms contained in them a final formula is presented for determining the information capacity of MAOM's, which also takes into account the relationship between the central frequency, diffraction efficiency and the width of the transmission band. Included in this formula is the acoustooptic figure of merit for the MAOM's material. On the basis of the formula for determining information capacity, a comparison is made of various acoustooptic materials arranged in order of an increase in the attenuation factor, α_0, which determines the attenuation of the power of the acoustic wave at the end of the acoustooptic conductor. It is demonstrated that the information capacity of an MAOM is determined to a considerable extent by the acoustooptic figure of merit of the material of the acoustooptic conductor and in addition by the height of this conductor, which determines the number of channels. The various materials studied are divided in terms of operating frequencies into three groups. With a permissible amount of attenuation of the acoustic wave at the upper frequency of the band equal to 2 dB/cm, materials with an attenuation factor of $\alpha_0 \geq 200$ dB/GHz$^2 \cdot$cm can be used at frequencies to 100 MHz, with $\alpha_0 \geq 8$ dB/GHz$^2 \cdot$cm at frequencies up to 500 MHz and with $\alpha_0 \geq 2$ dB/GHz$^2 \cdot$cm at frequencies to 1 GHz. A promising material for MAOM's for frequencies up to 600 MHz is single crystals of gallium phosphide and for frequencies up to 900 MHz, $Bi_{12}GeO_{20}$. As_2S_3 is promising for use at low frequencies.

9

The uniqueness of this study is that the results are based on taking into account the dependence of the MAOM's information capacity on the acousto-optic figure of merit of the acoustooptic conductor's material, diffraction efficiency and the power of the acoustic wave. Materials used in the same frequency band can be compared with respect to information capacity because the acoustic attenuation factor is used as the ranking parameter, and not the information capacity. Figures 2; tables 1; references 9: 6 Russian, 3 Western (1 in translation).
[218-8831]

ELECTRODYNAMIC ANALYSIS OF LOG-PERIODIC LOOP ANTENNAS

YATSKEVICH, V. A. and RUBAN, A. P.

[Abstract] An electrodynamic analysis is presented of a log-periodic loop antenna designed as a coaxial system of loops with each loop having two pairs of terminals situated on opposite sides of the loop, whereby one pair of terminals is connected to one distributing line and the other to another distributing line and both distributing lines are connected in parallel to a common excitation source. The round loops are arranged on the surface of a cone and form a log-periodic structure. This antenna radiates a linear polarization field and the electric field vector is oriented parallel to the magnetic plane of symmetry of the system. The solution to the problem of the excitation of a thin ring conductor is generalized for the case of a coaxial system of circular loops. Expressions are presented for drawing the directivity diagram and for computing the directive gain. The procedure for making an electrodynamic analysis is outlined. Calculations have demonstrated that there is a well formed active region in antennas of this type which is similar to the active region of a log-periodic dipole antenna and which consists of loops whose perimeter is close to the wavelength. Current phasing makes possible directional radiation in the direction of the antenna's vertex. The operating band of a log-periodic loop antenna is fundamentally unrestricted and is determined by the ratio of the diameters of the largest and smallest loops. It is demonstrated that with identical overall dimensions of the antennas a log-periodic loop antenna has an operating band which is expanded approximately 1.5-fold into the low-frequency region as compared with the operating band of a log-periodic dipole antenna. However, a characteristic disadvantage of log-periodic loop antennas is their poor directional properties in the low-frequency region. The log-periodic loop antenna discussed is similar in characteristics and design to a frequency-independent helical radiator but differs from it in the linear nature of the polarization of the radiated field and has the advantage that there is a strict and efficient method of designing it which makes it possible to design and optimize it on a computer. Figures 2; references 6: 2 Russian, 4 Western (1 in translation).
[218-8831]

METHOD FOR CORRECTING DISTORTIONS OF RADIO BRIGHTNESS DISTRIBUTION CAUSED
BY SIDE LOBES OF ANTENNA DIRECTIONAL PATTERN

YEGOROV, S. T., PLYUSHCHEV, V. A. and VLASOV, A. A.

[Abstract] The authors propose a method of successive approximations [SA]
for correcting amplitude distortions of radio brightness distribution which
are caused by the side lobes of the antenna directional pattern. The follow-
ing items are considered in the work: 1) Essence of SA method; 2) Convergence
of SA procedure; 3) Digital realization of SA methods; and 4) Practical
limitations superimposed on number of steps. It is shown that use of the
SA method makes it possible in accordance with a measured distribution of
the antenna temperature values, with a specified degree of precision, to
restore the distribution of the values averaged with respect to the princi-
pal lobes of the radio brightness temperature. This can be obtained during
a survey of the space of an "ideal" antenna with a directional diagram with-
out side lobes. After each approximation the degree of the amplitude dis-
tortions resulting from side lobes can be reduced $1-\beta/\beta$ times (β = scattering
factor of antenna). The number of approximations necessary in each practical
case depends on the width of the area of survey of the radiometer, the
precision of measurement of the values of the antenna temperatures and the
error of determining the directional diagram. Figures 1; tables 5;
references: 6 Western.
[88-6415]

TWO-FREQUENCY COMBINED DIPOLE ANTENNA ARRAYS

IL'INSKIY, A. S., PONOMAREV, L. I., BEREZHNAYA, I. V. and DOLGIY, A. V.

[Abstract] Combined multifrequency dipole arrays represent a combination
of single-frequency dipole arrays arranged one on top of the other in the
same radiating aperture. Their purpose is to reduce the overall dimensions
of an antenna operating at several frequency subbands. The characteristics
of these arrays are distorted because of the mutual influence of one antenna
on the other and at each frequency only one of the arrays in the combined
array is excited and the others represent passive scatterers. Maximum
distortions originate with identical polarization. The results are given of
a study of the influence of a passive array for the second subband on the
shape of the amplitude directional pattern, the level of side lobes and the

gain of the first-subband array in a two-frequency combined dipole array
with matching linear polarization in both frequency subbands. The combined
arrays are at a short distance from one another and have a finite number
of dipoles with a total electric length of all dipoles at the higher
frequency of not greater than 50 times the wavelength. With identical
polarization the principal distortions are governed by current induced in
the dipoles themselves. The electrodynamic model utilized for analysis is
a system of parallel cylindrical thin-walled dipoles saturated in a certain
cross section with concentrated e.m.f. of a certain frequency and each
passive dipole at this frequency is assumed to be loaded by a random com-
plex load in the cross section in which it is excited by concentrated e.m.f.
at the other frequency. The problem reduces to solving a system of integral
equations for the current in each actively and passively excited dipole in
both frequency subbands and then in calculating from these currents the
radiation field, directional pattern and input impedance of the actively
excited dipoles at each frequency. It is shown that the upper dipole array
exerts a shadowing effect resulting in lowering of the gain of the lower
array, distortion of the directional pattern, the appearance of additional
sidelobes, additional mismatching of its radiating elements and worsening
of its accuracy characteristics. The level of distortion introduced depends
primarily on the thickness of the dipoles of the upper array and on the
ratio of the frequencies of the combined antenna arrays. The heaviest
distortion in the directional pattern appears in the H-plane. The bottom
array acts as an additional shield for the upper array and exerts an influence
on its directional pattern and gain. Figures 9; tables 4; references:
4 Russian.
[218-8831]

INFLUENCE OF CORRUGATED STRUCTURES ON INTERACTION OF ANTENNA ARRAYS

MARTSAFEY, V. V. and SHVAYKO, I. G.

[Abstract] The mutual interaction of pencil-beam antennas can be reduced
by employing corrugated structures. A description and the results are given
of a study of the influence of corrugated structures on the interaction of
pencil-beam antenna arrays. The study is based on the results of the theory
of the aperiodic excitation of an infinite packet of semi-infinite planar
waveguides. This packet is divided into a transmitting antenna, receiving
antenna and isolator. An analysis is made of the functioning of isolators
of both the absorbing and purely reactive type. The elements of the re-
ceiving antenna are connected via matching elements and phase inverters
to an ideal adder which makes it possible for the receiving array to operate

on a common load. It is assumed that the dimensions of the waveguides make possible the propagation of only waves of the T type, that the waveguides' walls are infinitely thin and ideally conducting, that the amplitudes of incident waves in the transmitting array are equal, that changes in phase in the elements of each array are possible, and that the time dependence is determined by the factor $e^{-i\omega t}$. The isolation is the parameter characterizing the degree of interaction of antennas and it is defined as the ratio of the radiated power to the power in the input of the receiver. Isolation is estimated for different variants of filling the space between antennas. These include placing semi-infinite waveguides between the antennas and placing between the antennas short-circuited waveguides simulating a corrugated isolating structure. In the latter case in the infinite packet of semi-infinite waveguides, waveguides situated between the antennas are short-circuited by means of plungers lowered to a certain depth. A determination is made of coupling coefficients in an aperiodically excited infinite packet of waveguides. It is demonstrated that coupling between antennas is maximum when the principal maxima of the factors of the transmitting and receiving arrays are oriented toward one another. Even relatively small reactive structures have a substantial influence on isolation. Isolation is increased by means of corrugated structures with a channel depth of 0.22λ to 0.5λ, where λ is the wavelength, for the antenna dimensions and distances between them discussed. The effectiveness of corrugated structures depends on the method of exciting the antennas, generally on the phase shifts in the antennas. A corrugated structure exerts an insignificant influence on the directivity pattern of aperture antennas. Figures 3; references: 6 Russian.
[218-8831]

UDC 621.396.677.49:621.396.967.7

FORMATION OF SPATIAL CHARACTERISTICS OF DIRECTIVITY OF NON-PLANE AXISYMMETRIC ANTENNA ARRAYS BY COHERENT OPTICS METHODS BY MEANS OF VOLUME HOLOGRAMS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian
Vol 25, No 2, Feb 82
(manuscript received 8 Sep 80, after revision 26 Jan 81) pp 29-34

GRINEV, A. Yu. and TEMCHENKO, V. S.

[Abstract] A description is given of the algorithm and structure of a coherent optical processor for processing the signals of radiating elements of antenna arrays arranged on a non-plane axisymmetric surface, by utilizing the selective properties of volume holograms. The surface is formed by winding a plane curve around some axis. Arrays of this type make possible a wide-angle coverage of space without reducing directional properties. An algorithm is presented which makes it possible to form the spatial characteristics of the directivity of non-plane axisymmetric antenna arrays with a random distribution of receiving elements. A description

is given of a coherent optical processor which implements this algorithm, whereby a particular addressing rule is established between the radiating elements of the non-plane axisymmetric antenna array and the channels of a space-time light modulator located in the subject plane and accomplishing the input of the array's signals into the coherent optical processor. The coherent optical processor performs a two-dimensional Fourier transform of the aperture response from each ring of the array by means of a spherical lens. A volume hologram in the form of a transparency is placed in the spectral plane so that the Fourier response received from each ring is multiplied by its "own" transparency, by utilizing the angular selectivity of a volume hologram. In the output plane of the coherent optical modulator light responses are formed in the form of the directional pattern of the antenna array and correspond to the radio emission sources found in the array's area of coverage. It is demonstrated that the coherent optical processor with a volume hologram transparency accomplishes the parallel formation of the spatial characteristics of the directivity of non-plane axisymmetric antenna arrays. Implementation of the processor is discussed in terms of the angular selectivity of the volume hologram, which depends on the distance between the channels of the space-time light modulator and the focal length of the converting lens. The condition is given for obtaining non-overlapping responses from adjacent rings of the antenna array. Figures 3; references 9: 7 Russian, 2 Western. [218-8831]

SLOT ANTENNA EMPLOYING TRAVELING WAVE RESONATOR

GOROBETS, N. N. and NESTERENKO, M. V.

[Abstract] A description and analysis are presented of a slot antenna employing a traveling wave resonator, which is created by turning a rectangular waveguide with longitudinal or transverse slots into a ring forming a traveling wave resonator which is excited by a coupling element. With directional coupling the resonance of waves propagated in a single direction originates in the ring and the antenna makes it possible to radiate with circular or elliptical polarization. With nondirectional coupling standing waves are formed in the traveling wave resonator and the radiated field has elliptical polarization close to linear. Resonance takes place upon the condition that a whole number of wavelengths is accommodated in the waveguide ring. A determination is made of the energy characteristics and directivity diagram of a slot antenna employing a traveling wave resonator with nondirectional coupling of the main waveguide with the ring, i.e., with a longitudinal slot. The complex amplitudes of voltages in all slots are found, uniquely determining the energy characteristics and the radiation

field of the antenna in the long-range region. The calculated directivity
diagram is presented for one antenna of the type discussed and it is seen
to be funnel-shaped. It is demonstrated that the presence of a resonator
results in considerable narrowing of the frequency characteristics of slot
radiating elements. By retuning the traveling wave resonator it is possible
to shift the operating frequency band smoothly over the total range without
considerably changing the directivity pattern. The use of traveling ave
resonators makes it possible to create high-Q resonant slot antennas which
can be tuned mechanically or electrically. This approach can be employed
to create antenna systems which operate in various wave bands, since the
hollow center of the traveling wave resonator can accommodate additional
radiating elements. Figures 2; references 5: 4 Russian, 1 Western.
[218-8831]

OPERATIONAL METHOD FOR CHECKING MATCHING OF ANTENNA WAVEGUIDE SECTIONS
ON RADIO RELAY LINKS

ATAMANSKIY, V. I. and KOTENKO, A. V.

[Abstract] This article describes the operating principles of IR-4 and
IR-6 impulse reflectometers used for adjusting antenna-waveguide sections
of radio relay links. The pulse can be produced by the microwave trans-
mitter itself. The measurement scheme described has been used on "Druzhba"
GTT-6000/1920 equipment, and can be used with any radio relay equipment.
Figures 2.
[237-6508]

OPTICAL CABLE COMMUNICATION LINKS

[Article by G. I. Grodnev, engineer]

[Text]   The "Basic directions of the economic and social development
         of the USSR for 1981-1985 and up to 1990", confirmed by the
         26th CPSU Congress, has the following provision: "assimilate
         series of new types of fiber optic communication cables".
         This is an extremely urgent problem, since the production of
         ordinary electrical cables require a great deal of copper and
         lead, and the reserves of these metals in the worldwide balance
         are extremely limited. Our cable industry consumes up to 50%
         of the copper and 25% of the lead from all of the country's
         resources. It has recently become possible to replace the
         lead used for cable shields with aluminum, steel and poly-
         ethylene. However, there is yet no totally satisfactory re-
         placement for copper conductors, and the requirements for
         copper are increasing: there are provisions to increase the
         number of channel-kilometers of long-distance communications
         by a factor of 1.8 during the 11th Five-Year Plan, and 75%
         of this must use cable links. The creation of fiber-optic
         cables will provide a radical solution to the problem of
         replacing copper in cable production.

         This article examines the process of transmitting energy over
         an optical fiber and explains the physical phenomena which
         are opening the way to replacing copper with glass in communica-
         tion cables.

N. G. Basov and A. M. Prokhorov, creators of the optical laser quantum generator,
Soviet scientists and Academicians, laid the foundation for the development of
optical transmission systems. The operating principle is based on the emission
by the atoms of matter under the influence of an external electromagnetic field
of light quanta, or photons.

Figure 1. Laser operating
principle. Key: 1, beam.

16
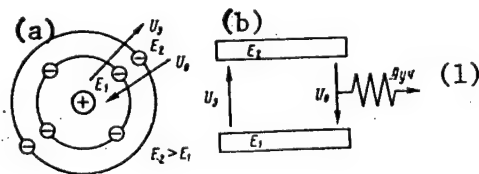
An atom of any substance (Figure 1a) consists of a positively charged nucleus and negative electrons rotating in their own orbits. The higher the orbit, the greater the electron energy ($E_2 > E_1$). If electrical voltage disturbs the atom and electrons are forced into a higher orbit, when they return to their previous orbit quanta of light — photons — are emitted. Electrical energy is thus expended (pumping energy U_e) and light energy is obtained (photon flux U_0) (Figure 1b). This flux, passing through a resonant system of mirrors, is amplified, thus resulting in a highly directional laser beam.

Various types of lasers are now known: semiconductor, solid-state, gas and others. A semiconductor laser (Figure 2) is a p-n semiconducting diode made of luminescent material capable of emitting light quanta or photons. Gallium arsenide with appropriate admixtures (tellurium, aluminum, silicon, zinc) are used mainly for this type of luminophor. The luminophor is excited by applied voltage, the carriers recombine and a photon flux — the laser beam — appears. Laser radiation differs from ordinary light, which represents chaotic photon movement, in that it is strictly phased and coherent, i.e., the movement of the light particles — photons — is matched in time and space.

A laser beam has a number of remarkable properties: it propagates over long distances, has strictly rectalinear direction with low divergence, and can carry a huge amount of information. Laser systems ordinarily use the visible spectrum of the optical band (10^{14}-10^{15}Hz) which corresponds to micron wavelengths.

In its simplest form, a glass fiber or optical cable used to carry a laser beam uses a two-layer construction (conductor-jacket) with different refraction indexes. The beam moves along the fiber and is reflected in zig-zag fashion (repeatedly) from the conductor-jacket boundary (Figure 3a). In order to prevent the radiation of energy through the jacket into the environment, the beam is directed toward the end of the cable at an angle of ϕ which is greater than the total internal reflection angle ($\sin\theta = n_2/n_1$). When $\phi \geqslant \theta$ (Figure 3b), there is only the reflected beam: there is no refracted beam, consequently, no energy is radiated into the environment, and all of the transmitted energy propagates efficiently along the fiber conductor. The quality and range of transmission depend on the transparency of the glass, i.e., the losses in it. The optical fibers which are now being manufactured have an average attenuation of about 5 dB/km. Developmental optical cables with fiber attenuation of 0.5 dB/km exist.

The basis of optical communications (Figure 4) is thus provided by an optical cable. The radiation source is either a semiconductor laser L or light-emitting diode SD, and the receiver is a photodiode FD. At the input to the optical cable, the electrical signals are converted to optical, and re-converted to electrical at the output. The primary system used for optical cable transmission is a digital PCM system. Systems with 30, 120, 480 or more channels are used.

Figure 2. Diagram of semiconductor
laser. Key: 1, light beam.
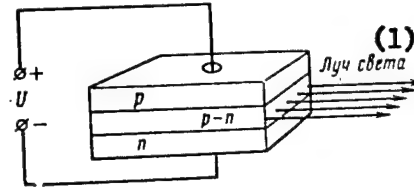
Besides saving copper, other advantages of optical cable include their bandwidth
and the capability of transmitting a large stream of information (10^4-10^5 channels),
low attenuation and frequency independence over a wide frequency range. Optical
cable attenuation at a wavelength of 0.85 μm amounts to 5 dB/km. Investigations
have established that when a wavelength of 1.3-1.7 is used the attenuation can be
reduced to 0.5 dB/km, i.e, the distance between regenerators can be increased to
80 km; in addition, optical cables are small and light in weight (optical cable
weighs 10 to 12 times less than electrical cable), and they are suitable for
installation underground.

Figure 3. Transmission over fiber
light guide: a - radiation present
($\phi<\theta$), b - radiation absent ($\phi\geq\theta$).
Key: 1, beam; 2, radiation.
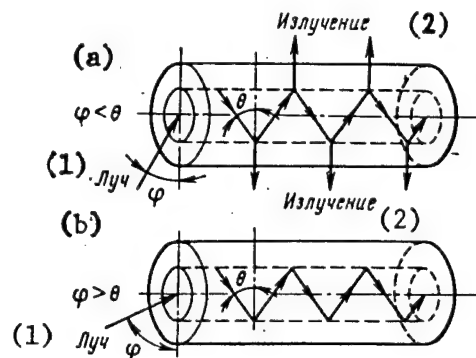
The high cost of production is a shortcoming of optical cables. However, as this
technology is mastered the cost of optical fiber should soon drop by a factor of 10.

Optical cables have begun to be used primarily for city automatic telephone ex-
change trunk devices, where they replace extremely metal-intensive electrical cables.
Several optical cable lines are already in operation in the USSR in IKM-30 and
IKM-120 transmission systems (Moscow, Gor'kiy, Leningrad). There are plans to
construct optical cable lines in other cities here during the 11th Five-Year Plan.

In the future, optical cables should be used in zone and backbone communications
networks.

An optical cable is constructed of one or several light guides (fibers) arranged
or twisted in a certain manner and covered with a protective plastic jacket.
Reinforcing elements are often included in the jacket or center of the cable, which
increase the breaking strength of the construction significantly.

Fiber light guides exist with a discontinuous profile (abrupt variation in the
coefficient of refraction) and gradient fibers (in which the coefficient refrac-
tion changes continuously, most often parabolically).

Low energy losses and low dispersion distortions are important requirements imposed
on light guides. These properties are present in alloyed quartz glasses,

18

multi-component silicate glasses and transparent polymers. However, the use of quartz glasses provides the best results.

A two-layer quartz fiber is obtained by chemical precipitation of silicon oxide on the outside surface of a quartz tube (jacket) from the gaseous phase at a temperature of 600-800°C. In order to obtain a smooth or abrupt change in the index of refraction of the blanks, borium, phosphorus or other compounds are added to the silicon pairs during defined stages of precipitation. The blanks are then pressed into a bar and a fiber of the required diameter is drawn from it. In order to increase the mechanical strength and to provide protection against outside influences, a plastic coating of polyamide, fluoroplastic or polyethylene is put on the fiber.

Figure 4. Functional diagram of optical communications:
1 – laser/light emitting diode;
2 – optical cable; 3 – optical signal; 4 – regenerator; 5 – photodiode; 6 – electrical signal;
7 – transmit interface; 8 – receive interface; 9 – PCM.
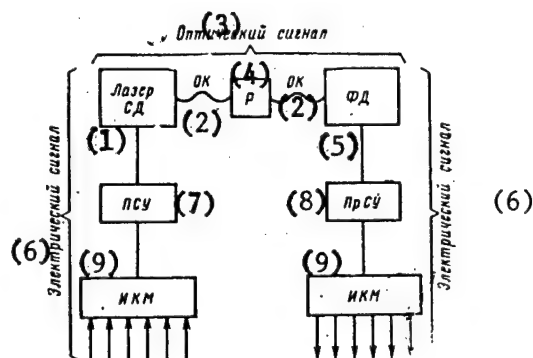
The last meeting of International Electrotechnical Commission subcommittee 46E in October 1979 adopted coordinated resolutions to standardize the following geometric parameters of fiber light guides: conductor 50±3 μm, jacket – 125 μm, protective coating – 200 μm.

Reinforcing elements which provide protection against mechanical stretching loads, and in some cases prevent shrinkage of plastic coatings, can be placed within the cable, or around it. Reinforcing elements which are used include both metal (aluminum, steel) and high strength braided synthetic materials (nylon, Kapron, etc.).

The exterior jacket used in optical cables are mostly of two-layer construction: first an absorbing envelope of porous plastic is put into place, and then the outside jacket, usually polyethylene. Aluminum corregated jackets with a protective polyethylene tube are also used.

A large number of different optical cable designs have now appeared around the world. In principle, they can be classified into the following three groups: traditional twisted-layer cables (Figure 5a); cables with a shaped plastic core with the optical fibers arranged around it (Figure 5b); and cables with flat construction consisting of stacks of strips containing fibers (Figure 5c).

Cables with shaped cores are used most widely in European countries. Flat cables made of stacks of strips, each containing between 6 and 12 optical fibers are used in the US. Japanese designs are also of interest. The gradient fiber they have created has low continuation and allows communication over a distance of 80 km without amplifiers.

19
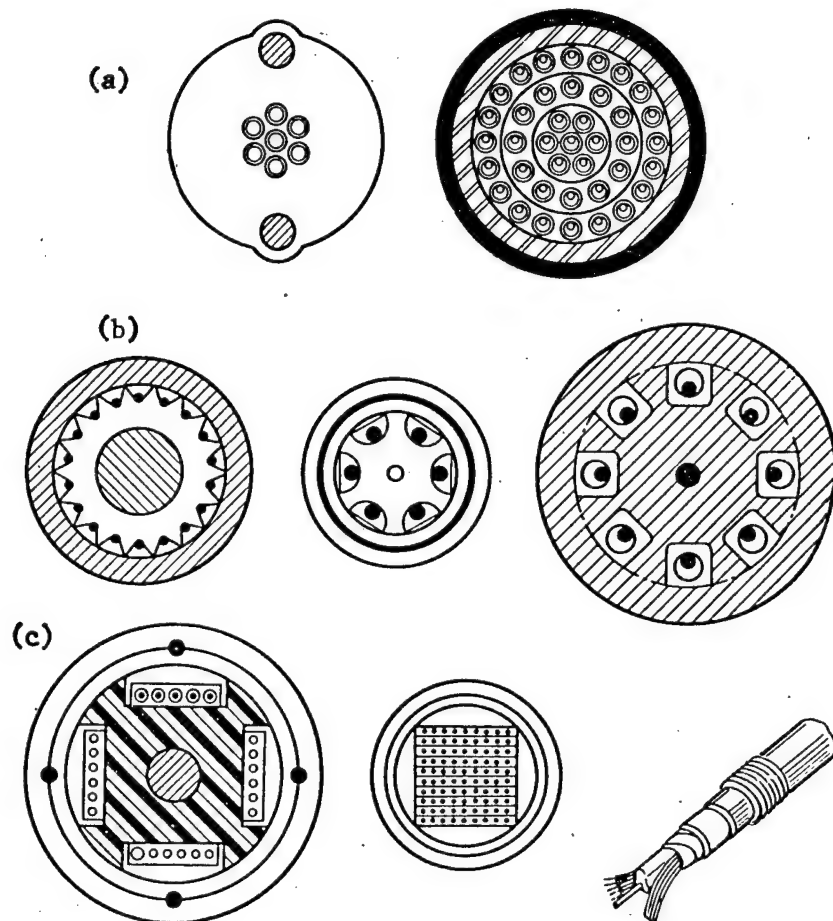
Figure 5. Optical cable construction: a — twisted layers;
b — use of shaped core; c — flat construction.

Figure 6. Influence of
gap (a) and lateral dis-
placement (b) when splicing
fibers. Key: 1, dB; 2,
numerical aperture.
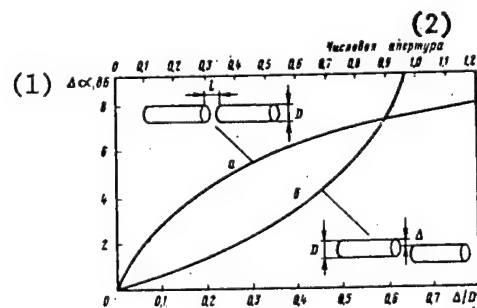
The installation of optical cables is one of the most important tasks involved in their utilization. Many different ways have appeared in recent years for joining structural cable lengths. These methods can be divided into two groups: stationary and operational installation. Stationary installation is used for cables intended for long-term operation, while operational is used for mobile reusable cables, where structural lengths must be connected and disconnected repeatedly.
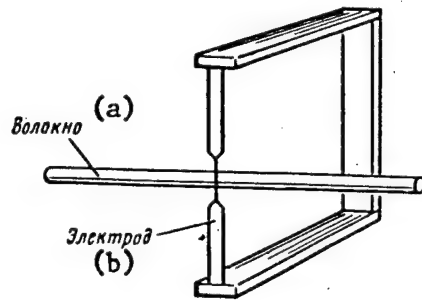
Figure 7. Electrical arc welding of fibers. a - fiber; b - electrode.
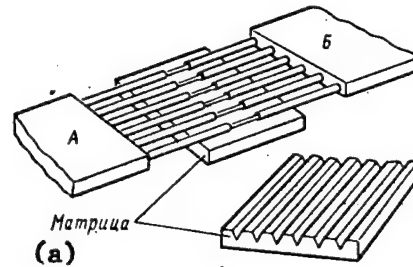
Figure 8. Arrangement of flat optical cables. a - matrix.

The main requirements for connecting devices are simplicity of construction, low transient losses, resistance to external mechanical and climatic effects and reliability. When connecting fibers they must be kept strictly coaxial, the geometry of their ends must be identical, and the ends must be perpendicular with respect to the optical axes of the fibers.
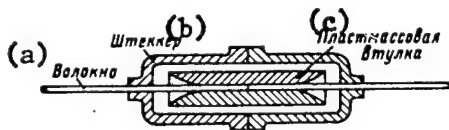
Figure 9. Plug connector
a - fiber; b - plug; c - plastic sleeve.

Figure 10. Capillary connection.

Figure 11. Use of heat-shrinkable tubing: a - original position; b - after heating; c - cable.

As Figure 6 indicates, end-to-end misalignment causes significant additional losses, and a gap between the fibers has a significant influence on the quality of the junction. The use of a matching medium between the ends of the fibers which has a coefficient of refraction different from that of the fiber core reduces significantly the quality of the joint.

21

The fiber ends are prepared by spalling and polishing them. The fibers are trued with the help of plastic tubes having the same inside diameter as the fibers being connected, or using a plastic matrix with V-shaped grooves which hold the fibers.

Electric arc welding is one method of stationary mounting (Figure 7). Nichrome electrodes are used for this purpose. A high voltage electric arc welds the ends of the fibers within two seconds at a temperature of 1000-1500°C. The junction losses are between 0.1 and 0.3 dB. The strength of the joint is 70% of that of a whole fiber.

In installing a flat optical cable (Figure 8), the fibers of the twisted ends of cables A and B are laid in the grooves of a matrix and filled with epoxy resin.

Plug-type connectors — mechanical joints which allow the construction lengths to be joined and separated — are used most extensively for operational installation. Analogous constructions are also used to connect cables to equipment. There now exists a large number of varieties of plug connectors, the most common of which is shown in Figure 9.

The following simple version of connecting fibers is of interest (Figure 10). A glass capillary with a melting temperature lower than that of the fiber is taken. The fiber with its prepared end is inserted in the capillary and held in place by locally heating the capillary and shrinking it about the fiber. Then the other fiber is inserted in the other end of the capillary and held in place with a special adhesive.

It is recommended that splices be sealed and protected with heat-shrinkable polyethylene tubing. This tubing is able to shrink in diameter when heat is applied, which produces a solid sealed jacket for the cable (Figure 11).

BIBLIOGRAPHY

1. Thematic issue of journal ELEKTROSVYAZ', No 12, 1980.

2. Teulin, I. I. "Volnovody opticheskoy svyazi" [Optical Wave Guides]. Moscow, Izdatel'stvo Svyaz', 1978.

3. Unger, G. G. "Opticheskaya svyaz'" [Optical Communications]. Translated from the German, Moscow, Izdatel'stvo Svyaz', 1979.

4. "Osnovy volokonno-opticheskoy svyazi" [Fundamentals of Fiber Optic Communications]. Translated from the English. Moscow, Izdatel'stvo Sovetskoye radio, 1980.

6900
CSO: 5500/1014

TELEVISION BROADCASTING VIA SATELLITE

[Article by V. Bykov, V. Dudkin and D. Zaytsev]

[Text]   History

The Communist Party and Soviet government exhibit continuing concern regarding
the extensive and thorough development of television in the USSR. We are doing
everything to encompass the entire USSR with television broadcasting and to provide
Soviet viewers, even in the most remote regions of our country, with the ability to
receive Central television programming at convenient local times.

It must be emphasized that the solution of this important government problem is
no simple matter, considering the extent of the territory of the Soviet Union and
the presence of inaccessible places and regions with low.population density.
Prior to 1967, this problem could be solved only by using ground facilities. Power-
ful television transmitting stations (5-50 kW) and low-power relays (1-100 W) were
built. The graph in figure 1 demonstrates the dynamics of the development of the
terrestrial transmission network in the USSR, while figure 2 shows the availability
of television broadcasting to the population by 5-year plans. It is apparent from
these figures that during the early stages the construction of a ground-based
transmission network was an efficient approach. Stations were built in heavily
populated areas of the country, and each facility to be brought on line meant a
significant increase in the number of viewers. For example, by 1 January 1961
100 powerful TV transmitters were built in this country, along with about 170 low-
power relays, which provided television broadcasting to approximately 35% of the
population.

However, during the following 5 years, i.e., up to 1966, when 190 powerful trans-
mitters and 480 low-power relays were already in use, the increase in the number
of viewers was only 20%. The efficiency of ground-based facilities then began
to drop sharply as TV stations were brought on line in sparsely populated regions.
For example, during the following 5-year plan, the addition of the same amount of
transmitting hardware as was brought on line during the previous 5-year plan pro-
duced a viewer increase of only 15%.
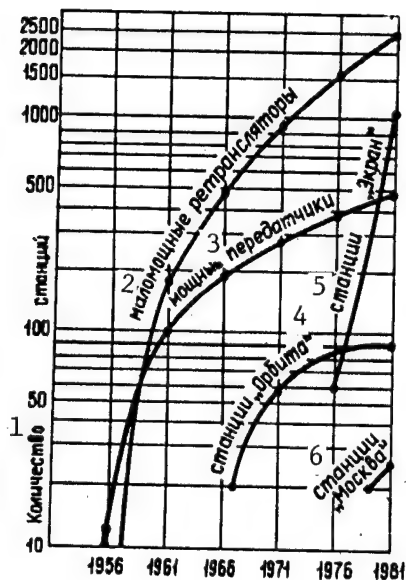
Figure 1. Development of USSR television transmission network. 1, number of stations, 2, low-power relay; 3, powerful transmitters; 4, "ORBITA" stations; 5, "EKRAN" stations; 6, "MOSKVA" stations.
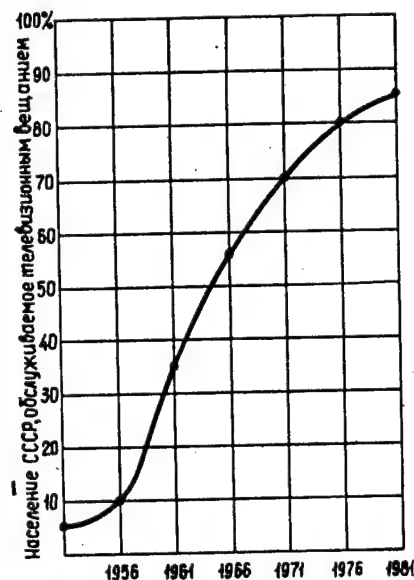
Figure 2. Availability of television broadcasting to population. 1, USSR population served with television broadcasting.

It became clear that continuing to add to the transmission network was inadvisable: in order to provide television broadcasting for 95% of the population it would be necessary to build more than 1000 powerful television stations and a large number of cable and radio relay links, which involves substantial capital investments and takes a great deal of time. It would be practically impossible to provide Central programming to 100% of the population.

A natural and fully realistic way to solve this problem within a short period was to use satellite systems, with which a single satellite could serve wide areas.

Technical and Economic Aspects

An important condition in the design of satellite television systems which determines their parameters and influences the choice of frequency range and technical characteristics is the economic indicator. Economically optical systems are designed on the basis of allowing for the cost of the space complex and earth stations, as well as the level of development of the ground receiving network.

Figure 3 shows examples of the relationship between the cost of these complexes and the satellite transmitter power P_b and Q-factor (sensitivity) of the ground receiving antennas $(G/T)_g$. The G in the ratio $(G/T)_g$ indicates the gain of the antenna and T designates the equivalent noise temperature of the earth station. It is apparent from the graph that the cost of the satellite and its launch depend to a great extent upon the power of the on-board transmitter. The higher the power, the greater the size and weight of the transmitter, the greater the power consumption, and the greater the size and weight of the power supplies; in the final analysis, the size and weight of the satellite are increased; requiring increased launch vehicle power.

Conversely, the cost of the receiving earth station becomes smaller, since good TV signal reception can be ensured with a more powerful on-board transmitter even when less sensitive, simpler and less expensive receiving installations are used.

Analyzing these relationships, we can reach the following conclusions:

- there exists an optimal relationship between P_b and $(G/T)_g$ for which the overall system cost is lowest;

- the optimal values of P_b and $(G/T)_g$ depend upon the number N of earth stations in the system. When N is large, there is a shift toward large values of P_b. Therefore, in designing mass television satellite broadcast systems it is best to use the maximum acceptable on-board transponder power, which ensures maximum simplification and cost reduction of the receiving network, and consequently of the system as a whole.

The highest acceptable relay power or, more precisely, the highest equivalent isotropic-radiated power, is determined on the basis of the Radio Communications Regulations, which limits the power flux density of satellite emission near the ground W_{sat}, in order to avoid interferring with other services, in each of the frequency bands allocated for satellite broadcasting or fixed satellite service.

According to the Regulations, television satellite broadcasting can use the 0.7 GHz, 2.5 GHz and 12 GHz bands; in addition, television can be transmitted within the framework of fixed services (to stationary ground facilities) in the 4.11 and 20 GHz bands (we shall not be considering higher frequency bands for the moment). Figure 4 shows the limitation of W_{sat} established by the Regulations for these frequency bands, as well as the maximum acceptable effective isotropic radiated power of the satellite and Q-factor $(G/T)_g$ calculated on the basis of these values of W_{sat} which are required to provide a given reception quality. This figure also shows the values of $(S_e/T)_e$ which are most convenient for economic calculations, where S_e is the effective antenna surface of the ground receiving facility, which characterizes its physical dimensions and therefore its cost. These relationships thus provide the basis for selecting the basic parameters of the on-board transmitter and the Q-factor (sensitivity) of the ground receiving stations $(G/T)_e$ or $(S_e/T)_e$.

Keeping the ratio $(G/T)_g$ or $(S_e/T)_e$ constant, it is then necessary to select values of G, S_e and T which result in the minimum cost of the earth station as a whole. These discussions go as follows: the larger the effective antenna area (S_e), the higher its cost; however, it is acceptable to use a less sensitive receiver (with higher noise temperature), having a correspondingly lower cost, and conversely. For some optimal values of S_e and T, the cost of the entire earth station, or the sum of the costs of the antenna and receiver, becomes minimal.

These data provide the basis for determining the relative cost of economically optimal satellite systems in each of the frequency ranges. The graph in figure 5 shows the results of the analysis, whence it follows that the most economically profitable systems are those operating in the 12 GHz range, where the least limitations imposed on W_{sat} make it possible to use receiving installations with low Q and low cost. Systems operating in the 0.7 GHz range can have comparable economic indicators; the cost of building satellite television systems in the other ranges is significantly higher.

Figure 3. Cost of satellite system as function of basic parameters; 1, system cost; 2, power figure of merit of earth stations, $(G/T)_g$; 3, entire system cost; 4, cost of N earth stations; 5, cost of 1 earth station; 6, cost of satellite and launch.
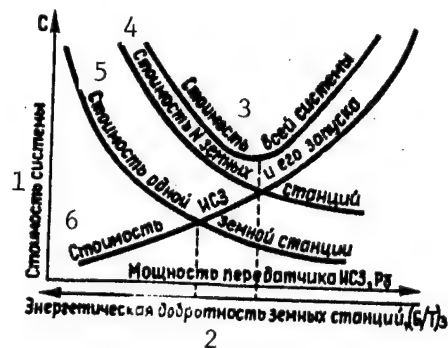
These considerations have made it possible to lay out a strategy in the area of selecting frequency ranges and determining the optimal parameters of satellite TV systems. However, there is another aspect which we must consider. The cost of each television receiver assumes a certain sum C_0 which the television purchaser pays to the government for delivery of television programming, i.e., for the technical equipment used to transmit and distribute TV programming. Obviously, the amount the government spends to deliver a program to one subscriber must not exceed C_0. Consequently, even if we disregard the satellite cost, which makes up a significant portion of the system cost, it is still necessary to try to meet the condition $C_{z.s}/n \leqslant C_0$ [1], where $C_{z.s}$ is the cost of the earth station, and n is the number of subscribers receiving programming from that station.

This means in practice that expensive receiving stations can be deployed only in large cities, and that satellite systems with inexpensive receiving stations must be provided to serve small populated regions.

"Orbita" System

Satellite facilities began to be used extensively for transmitting television programming in the USSR in 1967, when the "Orbita" network of earth stations was put into operation. TV programs are fed to these stations through the "Molniya-1" satellites in the 1 GHz band. The first 20 "Orbita" stations increased the number of Central viewers by more than 20 million [2].

Intensive construction of "Orbita" stations continued in subsequent years, with facilities appearing in practically all large cities in Siberia, the Far North and the Far East. There are now 90 of these stations, and beginning in 1974 most "Orbita" stations were switched over to the 4 GHz range to operate with the "Molniya-2" satellite, and are now working with the "Molniya-3", "Raduga" and "Gorizont" satellites. Table 1 shows the basic technical parameters of the "Orbita" system.

The "Orbita" stations have been described repeatedly in the technical literature [3,4]; therefore, we shall limit our attention here to only the most general characteristics. The station is based on a fully rotatable twin-reflector parabolic antenna 12 meters in diameter installed on a circular reinforced-concrete building; the building contains a liquid nitrogen-cooled input parametric low-noise amplifier, receiving equipment, an equipment complex for programmed aiming of the antenna toward the satellite, as well as a great deal of auxiliary and power equipment. The TV program received at the station is relayed to a local television center or to a powerful relay station and is sent over the air in the meter or decimeter frequency band.

Table 1. Basic Technical Parameters of Satellite Television Broadcast Systems

Parameters	System		
	"Orbita"	"Moskva"	"Ekran"
Frequency band, GHZ	4	4	0.7
Satellite transmitter power fed to antenna, W	8	40	200
Satellite transmit antenna gain, dB	22	30	33.5
Effective isotropic radiated power of satellite, dBW	31	46	56.5
Modulation method	FM	FM	FM
TV signal frequency deviation (without sync pulses), MHz	9.1	9.1	6.3
Type and diameter of receiving earth station antenna, meters	12 meter parabola	2.5 meter parabola	32/4 sheet wave channel*
Receiving earth station antenna gain, dB	51.9	37.5	30/23
Equivalent noise temperature of earth receiving station, K	100	200	800/800
Power figure of merit (G/T) of earth receiving installation, dB/K	29	14.5	1/−6
Signal/noise ratio at receiver input, dB	12.5	12.5	20.8/13.8
Signal/weighted noise ratio at receiver output in image channel, dB	53	53	54−55/48
Signal/noise ratio at receiver output in sound channel, dB	57	57	53−56/49

*The numbers in the table here and below in the numerator refer to a type-I earth station, while those in the denominator refer to a type-II station.

Figure 4. Optical parameters of satellite television systems. 1, frequency range, GHz.
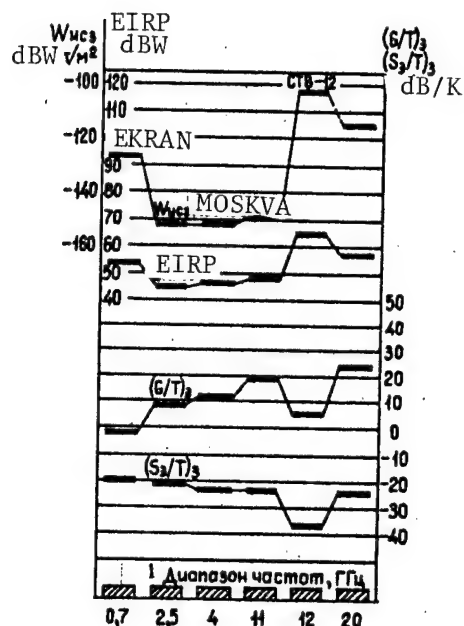
The "Molniya-3" satellite is now being used to feed the first Central television program to the "Orbita" station network in areas of the Far East, Kamchatka and Chukotsk; the other "Orbita" stations are being used increasingly to receive the second Central program, which is broadcast on a local time schedule.

The "Orbita" system was the world's first multistation television distribution system. However, for a number of technical reasons the system parameters were non-optimal, and the cost of an "Orbita" earth station is very high. Therefore, their construction was economically justified only in large cities and populated areas with population of at least 50,000. Even so, "Orbita" stations were also built in relatively small areas with populations of 5-10,000; this was done in the name of, and for the welfare of, the Soviet people.

Later, when it became necessary to build stations in populated areas with a few thousand residents, the development of the "Orbita" network was halted, and the task of building new, far less expensive satellite systems was put forth.

"Ekran" System

The "Ekran" system meets these requirements [5]. The "Ekran" satellite was first launched on 27 October 1976 and injected into a geostationary orbit with coordinates of 0° latitude and 99° east longitude. An experimental network consisting

28

of 60 receiving installations had been built by that time. The area serviced by the system encompasses 90 million square kilometers, which is about 40% of the entire country. The areas served include regions of Siberia, the Far North and part of the Far East.

The "Ekran" system was built in complete accord with the principles explained at the beginning of this article, using the 0.7 GHz band. The system uses inexpensive solid-state input amplifiers, simple wave channel multielement antennas and an on-board transceiver with the maximum possible power. This has made it possible to obtain the required signal/noise ratio and the required TV channel performance indicators while keeping the cost of the receiving installations low (Table 1). Since terrestrial television facilities also work in the 0.7 GHz band, the zones served by the system were selected so as to provide a sufficiently high power flux density in the zone and to make it possible to meet standards for interference field intensity outside the zone in territories of other governments [6].

This system is based on the "Ekran" satellite, which carries a high-power transmitter (200 W) and a huge folding phased transmitting antenna which contains 96 spiral elements (see illustration on back cover [not reproduced-Tr]). Widely spreading wings – solar batteries – provide power of up to 2 kW. The satellite's special high precision tri-axial stabilization position holds it in the required position with respect to the earth and boresights the transmitting antenna on the service zone.

Figure 5. Cost of optimal satellite TV systems in different frequency ranges.
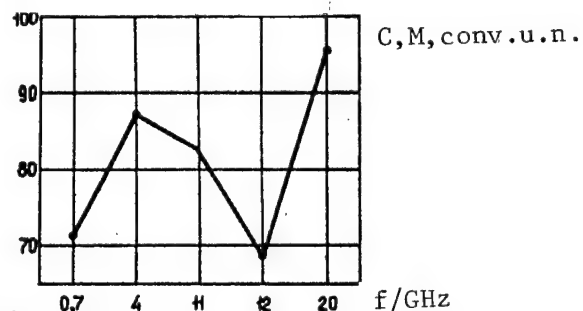
The "Ekran" system uses two types of ground receiving stations. The first type is designed to feed high quality TV signals to powerful TV stations which serve fairly large populated areas. These sets are configured with "wave channel" antennas containing 32 sheets. The receiving equipment consists of only a single rack, which receives, amplifies, demodulates and separates the sound and picture signals. The cost of this receiving installation is significantly lower than that of an "Orbita" station. The second type of installation is designed to feed the TV signal to low-power television relays, or over a cable distribution network. These systems use 4-sheet antennas and small receiving devices which translate the signal spectrum from the received frequency of 714+12 MHz to the spectrum of a channel in the meter band, and convert FM to AM. These installations cost almost 300 times less than an "Orbita" station. For operating convenience, receiving installations of this type have recently been combined into a single unit with a 1- or 10-W transmitting device.

The "Ekran" system passed all of its tests successfully. Its earth stations can be installed in large populated areas, in small villages, and can even serve individual geological prospecting parties. There are now over 1000 installations for this system around the country, and the network of stations continues to expand.

29

Equipment is being improved at the same time: for example, an input amplifier with a lower noise temperature is now being put into use, the production of special antennas for areas with difficult weather conditions have been proposed, as has the introduction to installations of the first type of an additional audio channel to carry radio broadcast programs.

All of the above allows us to state that the "Ekran" system is an extremely efficient means for organizing television broadcasting in areas of Siberia and the Far North of the USSR. Unfortunately, however, it cannot be used in other areas of the country, since footprint coverage of areas to the east and west of the existing service zone would be unavoidable. This would create intolerable interference with ground facilities belonging to other nations. It thus became necessary to create technical equipment with analogous simplicity and efficiency to transmit TV programming to areas of the Urals, Central Asia and the Far East.

"Moskva" System

In accordance with the task, the new "Moskva" satellite TV broadcasting system was developed and put into operation in the heavily utilized 4 GHz band. This system (technical parameters shown in Table 1) supplements the existing "Orbita" and "Ekran" systems, and makes it possible to encompass almost the entire country with Central television programming [7].

Table 2. Utilization of Equipment for Television Program Distribution in the USSR

Broadcast Zones	A	B	V	D	M	USSR Total
TV program provided	"Orbita-1"	"Orbita-2"	"Orbita-3"	"Orbita-4"	1 Central	
TV program delivery facilities	"Molniya" satellite, "Orbita" station network, landline	"Raduga-85" satellite, "Orbita" station network, landline	"Ekran" satellite, "Ekran" station network, landline	"Gorizont-53" satellite, "Moskva" station network, landline	"Gorizont-14" satellite, "Moskva" station network, landline	
Provision of broadcasts to population: % coverage	76.3	84.8	85.3	81.4	88.6	86.5

Special trunks carried by the new "Gorizont" series of geostationary satellites was used to build the "Moskva" system. The 40-watt on-board transmitter combined with the unidirectional on-board transmitting antenna makes it possible to obtain the maximum possible EIRP in that frequency band. At the same time, in order to observe the standards established by the Regulations for tolerable spectral flux density (-152 dBW/m^2 in the 4 KHz band), 2.5 Hz dispersion (scattering) of the carrier, and deviation of ± 4 MHz, was introduced for the FM signal transmitted by the satellite. The problem of electromagnetic compatibility with existing ground and satellite facilities was solved in this way.

The high power flux density of the signal near the ground made it possible to use an antenna with a relatively small reflector (2.5 m) at the "Moskva" receiving station, and also to use an uncooled parametric amplifier with a noise temperature of 100 K for the input device. All of the other radio equipment is contained in one small rack similar to the receiving installation used in the first type of "Ekran" system. No special buildings are required to house it.

The "Moskva" system can accomodate one high performance television channel and two audio channels. The low frequency TV picture and audio signals sent out by the station are input to transmitting devices whose type and power depend upon the required zone of coverage. The cost of the "Moskva" stations is about the same as that of the first type of "Ekran" receiving installation.

In order to provide television broadcasting for the entire USSR, there are plans for the "Moskva" system to use 4 "Gorizont" satellites arranged in geostationary orbit at 14° west longitude, and 53, 90 and 140° east longitude. "Gorizont" satellites at 14° west longitude and 53° east longitude are now providing the first Central program for broadcast zones M and G (see inside front cover) [not reproduced-Tr.], and satellites at 90° and 140° east longitude will provide the following coverage: second Central program for zone B and first Central program for zone A (replacing the "Molniya-3" satellite).

An experimental network of 30 "Moskva" stations is now in operation in this country. Tests which have been completed have confirmed that the technical treatments are correct, and this network of stations will soon be expanded vigorously.

Future Prospects

We have now examined the principles behind the construction of optimal satellite television broadcasting systems, and have become acquainted briefly with three domestic systems. One natural question is why three systems are needed which operate at the same time. The answer follows from the task of satellite TV broadcasting as formulated at the beginning of this article — providing the population of the country with multi-program television broadcasting allowing for local time zones.

For this purpose, the entire country has been divided into five broadcast zones (cf. map inside cover) [not reproduced], each of which covers the territory of approximately two time zones. Central TV programming must be fed to each of these broadcast zones with a two-hour time shift. Thus, the first Central TV program is produced in Moscow and broadcast in zone M, along with four copies "Orbita-1", "Orbita-2", "Orbita-3" and "Orbita-4", which are delivered to the corresponding

zones A, B, V and G. Since the first program is broadcast for more than 15 hours a day, five TV channels are required simultaneously to transmit all of its copies. These channels will be provided by the joint utilization of satellite systems, as well as terrestrial radio relay and cable links.

It is apparent from Table 2 that each of the broadcast zones now uses several technical facilities to transmit TV programming. This is explained by the fact that the most efficient distribution systems — the "Ekran" and "Moskva" — were introduced relatively recently and have not yet been developed quantitatively to the required extent. They will later assume the function of national distribution of the first TV program and its copies. The "Orbita" system in conjunction with landlines will distribute the second TV program and its three or four copies.

Television in the USSR is now faced with the task of providing the same conditions for all Central television programming. The problems of distributing TV programs from the union republics have not yet been resolved completely. All of this requires that we find new technical facilities, one of which should be the 12 GHz satellite TV broadcasting system.

BIBLIOGRAPHY

1. Shamshin, V. A. "Status and Prospects of Development of Television Broadcast Transmission Network". ELEKTROSVYAZ', 1977, No. 5.

2. Talyzin, N. V., Kantor, L. Ya., Tseytlin, M. Z. ""Orbita" Earth Station for Receiving Television Programs from Satellites". ELEKTROSVYAZ', No 11, 1967.

3. Kantor, L. Ya., Polukhin, V. A., Talyzin, N. V. "New "Orbita-2" Satellite Communications Station". ELEKTROSVYAZ', No. 5, 1973.

4. Talyzin, N. V., Kantor, L. Ya., Tseytlin, M. Z. ""Orbita" Ground Receiving System". RADIO, No. 9, 1967.

5. Minashin, V. P., Fortushenko, A. D., Borodich, S. V., Kantor, L. Ya., Bykov, V. L. "Basic Principles of "Ekran" System". ELEKTROSVYAZ', No. 5, 1977.

6. Shamshin, V. A. ""Ekran" on the Television Screen". RADIO, No. 5, 1977.

7. Kantor, L. Ya., Minashin, V. P., Povolotskiy, I. S., Sokolov, A. V., Talyzin, N. V. ""Moskva" Satellite Television Broadcast System". ELEKTROSVYAZ' No. 1, 1980.

OPTICAL FIBER COMMUNICATIONS LINES

KOTEL'NIKOV, V. A., vice-president, USSR Academy of Sciences

[Abstract] An introduction is given to a special issue of the journal
RADIOTEKHNIKA, devoted to the results of Soviet research on optical fiber
communications lines. The articles are grouped in four sections: optical
fiber circuits and their components, systems with optical fiber communi-
cations lines, measurements in these lines, and the servicing of them.
Optical fiber communications lines are regarded as promising for the crea-
tion of new measuring and data processing complexes required for monitoring
and controlling energy consumption and for the development of high-speed
computers and measuring systems and instruments. Plans are being made to
create a new type of sensor for various physical quantities based on
measuring the parameters of an optical fiber under the effect of a change in
various characteristics of the environment. A survey is presented of the
topics covered by Soviet and foreign publications, in relation to optical
fiber communications lines. Included among the advantages of optical fiber
communications lines over existing cable communications systems are the
considerably greater distance between repeaters, enormous carrying capacity
and a broad band of frequencies which can be transmitted, high noise
immunity in terms of electromagnetic fields, low crosstalk levels, relatively
low cost of materials required for creating the glass fiber and cable based
on it, complete electrical insulation of input and output devices, and the
relatively small size and bulk of an optical fiber cable.
[217-8831]

OPTIMIZATION OF OPTICAL FIBER DATA TRANSMISSION SYSTEMS

BERG, V. P., GUS'KOV, N. A., OBUKHOV, N. F., POKROVSKIY, V. R. and
STAROBINETS, I. A.

[Abstract] A variant is discussed of the design of a multiterminal data
transmission system which operates through a parallel "Interfeys-T" inter-
face with time-division multiplexing of signals. The reliability and data
transmission speed are determined chiefly by the parameters of the optical
fiber communications line used. An optimization procedure is discussed,
consisting of two steps: 1) Determining the required transmission speed;
and 2) Optimizing the main parameters of the optical fiber communications
line. The operating principle and data transmission speed in a multiplexed
optical interface are discussed. The "Interfeys-T" is used at group
programmable user stations for interfacing the central control unit with 8
input/output units over a range of up to 500 m through 22 functional lines.
Identification signal tracking is used in the transmission of bytes of
data in the "Interfeys-T". A comparison is made of time diagrams for the
transmission of a single byte of data from the central control unit to
input/output units in a non-multiplexed and multiplexed "Interfeys-T".
Calculations demonstrate that with the existing mass-produced electronic
components the transmission speed in an optical multiplexed "Interfeys-T"
over a range of greater than 150 m can even surpass the transmission speed
in an electrical non-multiplexed interface. The "Interfeys-T" optical
interface consists of a set of optical fiber communications lines of various
lengths having various carrying capacities. A single line with an optical
splitter cannot be used because it is difficult to guarantee the required
reliability of data transmission on account of the low power of radiating
elements and the existence of considerable attenuation in splitters. The
system approach is used to optimize, in terms of data transmission reliability,
optical fiber communications lines used in the "Interfeys-T". The optimiza-
tion problem is formulated as follows: With assigned specifications for
data transmission range and speed, it is required to determine the key
parameters of an optical fiber line making possible the maximum signal-to-
noise ratio in the receiver's output with fixed power of the transmitter.
The signal-to-noise ratio here is influenced by matching of the carrying
capacity of all components of the system, chiefly of the light conductor and
receiver. It is demonstrated that for each line with assigned length of the
light conductor and value of B, where $B = K_i R_{vo}$, where K_i is the redundancy
factor and R_{vo} is the data transmission speed of the optical fiber communica-
tions line, optimum values exist for light conductor parameters σ and A_0
with which the signal-to-noise ratio will be maximum, where σ is the linear
attenuation of the light conductor and A_0 is its numerical aperture.
Figures 5; references 3: 2 Russian, 1 Western.
[217-8831]

OPTICAL FIBER DATA TRANSMISSION SYSTEMS FOR AUTOMATED CONTROL SYSTEMS

BERG, V. P., VOROTNIKOV, V. L., GUS'KOV, N. A., KISLENKOV, G. V.,
MAKOVETS, G. K., OBUKHOV, N. F., POKROVSKIY, V. R. and YUDENKOV, V. S.

[Abstract] A description is given of the VOSPI-T and VOSPI-7920 model
optical fiber data transmission systems (VOSPI's) developed to replace
electrical lines operating through the "Interfeys-T" and YeS-7920 inter-
faces used for interfacing a computer with peripherals in an automated
control system. The replacement of electrical lines by optical makes it
possible to reduce considerably the amount of cable used in parallel inter-
faces for the multiplexing of signals and to reduce crosstalk, as well as
to gain the other advantages of optical fiber communications lines. The
VOSPI-T is based on the following engineering solutions: time-division
multiplexing of the information of parallel lines of the interface into a
single serial line; the transmission of serial data in the form of pulse
signals in 1V2V format; the separation of synchronizing signals by the cor-
relation method at the receiving end of the serial line; filling pauses in
the transmission of data in the serial line with 1V2V format signals;
using band amplifiers of the photodetector's signal in receiving units;
dividing and uniting signals of the group control unit and input/output
units in the electrical part of the system; and a self-contained structure
for the system in terms of design and power supply. The VOSPI-T system
consists of individual structurally complete units, including a group
conversion unit (BPG) alongside the group control unit (GUU) and eight
unit conversion units (BPU's) alongside the input/output units. The BPG
is connected with the BPU's by means of KVSP-50 optical cables. The BPG
includes a conversion unit, eight optical transmitters and eight receivers,
and the BPU includes a conversion unit and one optical transmitter and one
receiver. The VOSPI-7920 unit is also self-contained and consists of
individual identical units arranged around a control unit, and of the con-
trol unit and two optical cables. Each unit contains a coder, decoder and
circuit for matching the input and output with the interface line, which
altogether are called the conversion unit, as well as a transmitter and
receiver of optical signals and a power supply. Figures 2; references 7:
5 Russian, 2 Western.
[217-8831]

LARGE-APERTURE OPTICAL FIBERS WITH RIGID OUTER COATING

ALEKSANDROV, I. V., FEL'D, S. Ya. and SHUSHPANOV, O. Ye.

[Abstract] Optical fibers with homogeneous glass conductor and polymer
shell feature low losses under excitation and at bends, but their numeri-
cal aperture decreases sharply as the temperature drops. Here the mechanism
of this decrease of numerical aperture due to cooling is analyzed by estab-
lishing the temperature dependence of the refractive index for a glass-
polymer fiber as well as the role of the physical properties (coefficient
of linear thermal expansion and Poisson ratio) of the polymer and the role
of fiber dimensions (ratio of outside radius of polymer shell to radius of
glass conductor inside). The changes in numerical aperture are essentially
attributable to changes in the polymer density due to temperature changes.
On this premise is developed a modification of the fiber design. This in-
cludes coating the polymer shell with a thermoplastic material such as
polystyrene, silicone elastomer, or polymethyl methacrylate. From the
equation of thermoelasticity for thermal deformation of a triple-layer
cylindrical structure are determined parameters of the coating process and
dimensional parameters of the fiber layers which will ensure satisfactory
performance within a given temperature range. Typically, deposition of a
coating from a melt can extend the range of operating temperatures by 30°,
while doping the glass conductor with germanium extends it by only 10°C
with the same increase of the numerical aperture. Figures 3; references 11:
9 Russian, 2 Western.
[203-2415]

STUDY OF CHARACTERISTICS OF FIBER LIGHT GUIDE BY BACKSCATTERING METHOD

GRIGOR'YANTS, V. V. and CHAMOROVSKIY, Yu. K.

[Abstract] The backscattering method, also called the OTDR (Optical Time
Domain Reflectometer) method, is used to diagnose optical fibers and cables
based on them and has the advantages: 1) That it makes it possible to
determine the distribution of attenuation of light over the length of an
otpical fiber and cable without destroying them and when access to only one
end is possible; 2) That it is a sufficiently general-purpose method suited
for studying a number of parameters of optical fibers; and 3) That it can

be used to study various physical processes and to create distributed sensors. The theory of the backscattering method is discussed and the most widely used variants of the practical implementation of the method, in addition to its basic application for studying the properties of fiber light guides, chiefly of the multimode type, are discussed. The OTDR method was suggested by M. K. Barnoski and S. M. Jensen (1976), and by S. D. Personik (1977) in Western journals. It is evident from the theoretical discussion that changes in all parameters of fiber light guides result in a change in the backscattering signal and therefore it is important to know the individual contribution of fluctuations of each parameter to the total signal. The greatest influence is exerted by variations in the numerical aperture along the length of the light guide and the backscattering pattern is very sensitive to variations in the diameter of the light guide's core. The experimental apparatus for practical implementation of the backscattering method includes a pulsed light source, i.e., a laser with sufficiently high radiated power, a light divider to separate light flux traveling in opposite directions and a photodetector and a system for processing measuring results. An arrangement is suggested which utilizes a high-power pulsed ionized argon – neodymium laser in combination with a multimode light guide approximately 300 m long, making it possible to study backscattering over a broad region of the spectrum. In addition to application of the method in measuring attenuation, the method makes it possible to gain additional information on the mechanism of attenuation, e. g., on the distribution of OH^- ions over the length of the light guide. It also makes it possible to identify local inhomogeneities, such as imbedded particles, in the light guide's core. Studying backscattering is a very sensitive method for studying fiber couplers. Figures 5; references 28: 5 Russian, 23 Western. [217-8831]

OPTICAL FIBER INTERFACES FOR COMPUTING SYSTEMS

KALMYKOV, I. V., KORZINKIN, V. S., KUZ'MIN, V. I., PROKHOROV, A. M., SIMACHEV, N. D., SISAKYAN, I. N. and CHERNYSHEV, A. P.

[Abstract] The extensive practical utilization of optical fiber communications lines in computing systems is hampered at the present time by the absence of a methodology for designing an optical fiber communications line for a specific purpose. Questions relating to choosing methods of designing and to synchronizing and using optical fiber communications lines for computer interfaces are discussed. The approach of finding the optimum variant is applied. An algorithm is presented for determining the optimum branch of a problem-oriented graph. This algorithm can be used not only for designing the entire system but also for solving particular problems. The final variant is shown to be one in which cycle synchronization is accomplished

by means of start pulses which differ in duration from information pulses, with equalization of the amplitude-frequency response of the receiving channel. Two examples are given of the practical implementation of optical fiber communications lines in computing systems using CAMAC equipment, minicomputers of the "Elektronika-60" type and YeS [Unified Series] computers. The purpose of creating optical fiber interfaces is to replace the great number of wire lines ordinarily required by two optical fiber light guides. The synchronous principle of operation must be implemented in a CAMAC-"Elektronika-60" interface and the asynchronous principle in the input/output interface for a YeS computer. Optical fiber interfaces all use time-division multiplexing, pulse position modulation, equalization and minimum transmission delay. An interface with optical fiber communications lines created for linking an "Elektronika-60" computer and CAMAC controller makes it possible to replace 62 wire lines with two optical fiber light conductors. The probability of error of this interface is not worse than 10^{-9} and it utilizes optical fiber cables with a core diameter of 60 microns, a light-emitting diode, superluminescent diode or semiconductor laser as a radiating source, a pin diode as a photodetector and series 131, 155 and 531 microcircuits. An interface created for YeS computers is designed as an accessory to existing standard equipment and has a clock frequency of 60 MHz with an added delay of not greater than 900 ns per byte of transmitted information and transmission error probability of not greater than 10^{-9}. Figures 10; tables 2; references: 2 Russian. [217-8831]

POLARIZATION PROPERTIES OF SINGLE-MODE AND FEW-MODE FIBER LIGHT GUIDES

GUR'YANOV, A. N., GUSOVSKIY, D. D., DEVYATYKH, G. G., DIANOV, Ye. M., KARASIK, A. Ya., KOZLOV, V. A., MIRAKYAN, M. M., NEUSTRUYEV, V. B. and PROKHOROV, A. M.

[Abstract] A description is given of single-mode fiber light guides with strong and mild birefringence and the results are given of a study of polarization properties of these light guides under external influences. The experimental apparatus for measuring the polarization characteristics of these light guides consists of an He-Ne laser with wavelength of 0.63 micrometer serving as the source of linearly polarized radiation, and a combination of quarter-wave plates and a polarizer making it possible to introduce into the light guide, by means of a microlens, linearly polarized radiation with any polarization angle. The ends of the light guide are immersed for the purpose of reading sheath modes. The polarization state of the output radiation passing through the lens and a diaphragm and striking a photodiode is analyzed by means of an analyzer or a Senarmont compensator. The single-mode light guide with mild birefringence studied had a nominally round core

of SiO_2+GeO_2 and a sheath of SiO_2 and was fabricated by the CVD (chemical vapor deposition) method. The difference in refractive indexes of the core and sheath was $2.4\cdot10^{-3}$ and the characteristic parameter at wavelength of 0.63 micrometer equaled 2.3. The phase delay was determined by means of a Senarmont compensator when exciting the light guide with linearly polarized radiation with an angle of 45 degrees to the principal axes. The measured delay equaled 15 deg/m. The results show that a high degree of polarization of the output radiation is maintained in a light guide of this type over a length of 100 m with two perpendicular orientations of the direction of polarization of the introduced radiation coinciding with one of the principal axes of the light guide. A study of the influence of bends and twists on the amount of birefringence in a single-mode light guide with mild birefringence demonstrated that the polarization state in a light guide of this type is sensitive to external influences. This property can be exploited to create various optical fiber sensors. Single-mode light guides with mild ($2.6\cdot10^{-8}$) and strong ($1\cdot10^{-5}$) birefringence are both able to maintain linear polarization under single-mode conditions. Figures 4; references 13: 4 Russian, 9 Western.
[217-8831]

FREQUENCY RESPONSE OF FIBER LIGHT GUIDES

BABKINA, T. V., GRIGOR'YANTS, V. V. and SMIRNOV, V. B.

[Abstract] A study is presented of experimental evaluation of the information properties of fiber light guides of various types. The information properties of various light guides differ drastically and they often impose major limitations on the length of optical fiber communications lines. Recently more and more often the concepts of the transfer function and response function have been used in studying fiber light guides. It is demonstrated that the formalism of frequency response is based on a Fourier transform of pulsed optical signals. Parameter $h(\omega)$, representing the Fourier spectrum of the response function, is often called the complex gain and $|h(\omega)| = A(\omega)$ is called the amplitude-frequency response. The phase-frequency response is symbolized by $\phi(\omega)$. The frequency response of a fiber light guide exists in the physical sense only in the vicinity of the carrier, but since transmitted information is in a time relationship to the carrier's envelope, the frequency response can be defined as the dependence on frequency of the frequency gain of the envelope of the optical signal with intensity modulation. Deviation of the real amplitude-frequency response in the region of a droop from a linear relationship and the change in the slope of this droop are usually regarded as amplitude-frequency response characteristic properties in analyzing frequency response.

39

The same holds true, analogously, for phase-frequency response. A time
method is suggested for measuring frequency response whereby pulsed optical
signals are recorded in the input and output of a fiber light guide and they
are jointly processed in the time or the frequency region. The process of
measuring pulsed optical signals inevitably introduces distortions into
determinations of frequency response. The conditions for obtaining an un-
distorted frequency response are derived and a discussion is presented of
the influence of the multimode conditions for the propagation of optical
radiation by a fiber light guide on the form of the amplitude-frequency
response. The influence of excitation conditions on the form of the ampli-
tude-frequency response and the bandwidth is discussed. Excitation condi-
tions determine the distribution of energy between modes propagated through
a fiber light guide. The dependence of the bandwidth on the angle of entry
of radiation into a fiber light guide is discussed. A study of the fre-
quency response of specific fiber light guides made it possible to conclude
that it depends as a rule on excitation conditions, the length of the light
guide and the refractive index profile. It is recommended that measurements
be made of the frequency response of specific fiber light guides by using
a mode mixer in the light guide's input and that the results be included on
the light guide's data sheet. This method makes it possible to obtain
highly reproducible measurement results regardless of the excitation source.
Figures 4; references 13: 2 Russian, 11 Western.
[217-8831]

PRODUCING BLANKS OF 'GRADAN' OPTICAL FIBERS IN AUTOMATED EQUIPMENT
(MODEL UIZS-1)

GRIGOR'YANTS, V. V., ZHABOTINSKIY, M. Ye., IVANOV, G. A., ISAKOV, V. N.,
KORENEVA, N. A., NOVIKOV, A. G., PETYUKEVICH, V. V. and STOROZHEV, V. V.

[Abstract] Blanks of optical fibers are most widely produced by chemical
deposition from the vapor phase, a process which yields single-mode and
multimode fibers with excellent performance characteristics. The necessary
profile of the refractive index is attained by doping the quartz glass with
various impurities and varying their concentration in layers successively
deposited during forward and reverse strokes of the heating torch. Auto-
matic programmed preparation of the initial vapor-gas mixture and profiling
of the fiber blank is the only possible way to achieve the desired charac-
teristics. The first equipment of this kind in the Soviet Union, the model
UIZS-1, was developed at the Institute of Radio Engineering, USSR Academy
of Sciences, and its Special Design Office for production of "Gradan" opti-
cal fibers. It has been in operation successfully for 3 years. It consists
of two main quartz tubes, on both sides of a multinozzle gas torch, two

travel-limit switches, a gas flow regulator, a filter, four Teflon bubbler-batchers ($SiCl_4$, BBr_3, $POCl_3$, $GeCl_4$), a control module, a programmer with a 15VSM-5 or D-3-28 control computer, a neutralizer of reaction products (with 10-20 wt.% NaOH solution) with a powder scrubber, and a drying station. It produces a line of gradiental fibers with typical characteristics: outside diameter 120+5 micrometer (multimode 150+3 micrometer), core diameter 5-7 micrometer (multimode 60+3 micrometer), attenuation 3-6 dB/km at 0.85 micrometer wavelength, numerical aperture $\Delta n = 0.004-0.006$ (multimode 0.2-0.4), signal dispersion in multimode fiber 0.6-4 ns/km. The authors thank members of the Special Design Office for help in building the UIZS-1 equipment, and members of the Institute of Radio Engineering V. A. Detinich, A. A. Zamyatin for extruding optical fibers, T. V. Babkina, S. V. Mertsalov, Yu. K. Chamorovskiy and S. V. Shreyber for measuring the parameters of optical fibers. Figures 6; tables 1; references 8: 2 Russian, 6 Western. [203-2415]

UDC 621.373.826 : 621.396

DEVICE FOR WELDING OPTICAL FIBERS AND ITS EXPERIMENTAL USE IN
FABRICATING ELEMENTS OF MEASURING INSTRUMENTS

ZHARKOV, K. I., NAYDA, B. P., OLEYNIKOV, A. D., PERSHAKOV, V. V. and
KHOVRACHEV, V. G.

[Abstract] A description is given of optical fiber splitters and their fabrication technology, and a device for fabricating them. Splitters are employed in various measuring instruments used in testing optical fibers and cables under production conditions and in use in communications lines. The device consists of a high-voltage unit and mechanical adjusting unit on which electrodes are installed, between which an electric arc originates when high voltage is supplied from the source. A thyristor control circuit connected to the primary winding of a high-voltage transformer makes it possible to regulate the arc's burning mode over a wide range. The transformer's secondary winding is connected to welding electrodes. The arc current can be varied from 4 to 22 mA, making it possible to weld optical fibers of various diameters and compositions, and a milliammeter is provided on the high-voltage source's face panel for the purpose of indicating the arc's current. The optical fibers are laid in a V-shaped channel on the stage of the mechanical assembly and are fastened in special clamps, one of which makes it possible to feed the fiber lengthwise. Two vertically positioned tungsten electrodes are brought to the fibers to be welded so that the welding point is located between the ends of the electrodes. A special magnifying lens is provided for precise alignment of the welding point and electrodes. After adjustment, the high-voltage source is switched on and an arc discharge originates between the electrodes and the fibers are welded. The welding unit has been used to produce two kinds of splitters,

one made of multicomponent glass and one made of quartz glass. The splitters were fabricated from fibers having an external diameter of 80 microns and a center core diameter of 60 microns, in the first case. The welding of a shorter length to a longer length at the latter's approximate midpoint, for example, results in symmetric positioning of the leg of the resulting Y-connection relative to its two prongs. This symmetry is the result of surface tension originating in the welding process. Quartz glass splitters were made from fibers having a diameter of 150 micrometers and a center core diameter of 60 microns. The ends of the fibers were ground at an angle of 1 to 2 degrees to their axes and were joined together at the resulting flat surfaces, and the connecting point was welded. The welded section was then trimmed and ground to a diameter equal to the diameter of the welded fibers. Figures 3.
[217-8831]

INTERCOMPONENT INTERACTION IN MULTIELEMENT INTEGRATED PHOTODETECTORS FOR OPTICAL FIBER COMMUNICATIONS LINES

OSINSKIY, V. I., VRUBLEVSKIY, L. L., ZALESSKIY, V. B. and
MALYSHEV, S. A.

[Abstract] Increasing the degree of integration results in an increase in interaction between components of integrated circuits; in multielement photodetectors this results in a reduction in spatial resolution. The creation of high-speed multielement photodetectors for optical fiber communications lines is discussed, along with methods of reducing crosstalk between the elements of a photodetector. High-speed multielement integrated photodetectors can be created on the basis of pin photodiodes, representing one of the most promising kinds of structures for them. In order to produce a low level of crosstalk it is necessary to make it possible to absorb all the radiation within the limits of the photodetector's space charge region. In order to obtain a high crosstalk attenuation factor with long-wave radiation a space charge region of great width is necessary. The preferred method of achieving this is to reduce the active thickness of the structure and create a reflecting metallic coating on the back side. In structures of this sort the p- and n-regions are made fairly thin and the thickness of the active region of the photodetector, which is the region which gathers generated photocarriers, is reduced to the dimensions of the space charge region. The reflecting metallic coating turns the radiation which passes through the structure without absorption back into the bulk of the semiconductor. Multielement integrated photodetector structures were developed and studied in which the active regions were produced by two methods: 1) By selective chemical etching of local

42

membranes of specific thickness; and 2) By the creation of thin isolated single-crystal regions in a supporting substrate of polycrystalline silicon. Crosstalk was reduced in structures of the membrane type by introducing between the photodetector wafers with a concentration gradient an impurity promoting the separation and transfer to the nearest p-n junction of carriers generated by radiation. These photodetector structures have 20 photodetection elements arranged in two rows with spacing of 300 micrometers. Curves illustrating the dependence of the crosstalk attenuation factor on the distance between photodiodes in a multielement photodetector show that in structures with dielectric isolation higher crosstalk attenuation is possible than in a membrane structure. With a distance between elements of 250 micrometers it is possible to produce a crosstalk attenuation factor equal to or greater than 60 dB for optical radiation with wavelength of 0.9 micrometer. Multielement photodetectors with dielectric isolation of elements with a distance between elements equal to or greater than 250 microns can be used in communications lines for transmitting digital and analog information, whereas those of the membrane type can be used only in lines for transmission of digital information. Figures 5; references 4: 2 Russian, 2 Western.
[217-8831]

AUTOMATED MEASURING COMPLEX FOR STUDYING PARAMETERS OF OPTICAL FIBER COMMUNICATIONS LINES

ANISHKEVICH, N. N., LUKASHEV, V. M. and VIZNER, A. A.

[Abstract] Automated measurement of the parameters of elements of optical fiber communications lines in the time region is discussed, as well as a measuring complex designed for this purpose. The basic oomponents of the measuring system are an "Elektronika 100-I" minicomputer, a data transmission interface and S7-9 sampling oscillograph, a program-controlled sweep unit, two F-4222 analog-digital converters, two F-723/1 digital-analog converters, and a nanosecond-range optical test signal generator including a wideband electrooptical modulator utilizing a lithium tantalate crystal, and a pulse shaper utilizing charge-storage diodes. The electrooptical modulator has parameters which are optimum for conditions of wideband modulation. This modulator operates in the traveling wave mode and the carrier and modulating waves are in synchronism over a wide frequency band with the characteristic impedance of the modulator and exciting waveguide matched. The electrooptical modulator consists of electrodes, a lighium tantalate crystal, fluoroplastic plates, high-frequency connectors and a case. Birefringence is thermally compensated by means of an optical and electronic circuit for the purpose of stabilizing the modulator's parameters over a wide temperature range. The modulator contains two

identical crystals whose optical axes are antiparallel and are separated by
a half-wave plate. High-frequency coaxial connectors connected to the
modulator's electrodes are used for input and output of the modulating
signal. The modulator's half-wave voltage is 35 V. The position of the
electrooptical modulator's working point in the maximum contrast region is
stabilized by means of a specially developed electronic unit. The computer
controls the measuring process and converts from time parameters to fre-
quency parameters by employing a discrete Fourier transform. The measuring
complex described makes it possible to expand the capabilities of standard
instruments and to program and automate the process of obtaining and pro-
cessing experimental data in selecting and matching the elements of optical
fiber communications lines. Figures 5; references: 2 Russian.
[217-8831]

UDC 621.394.42

RING-TYPE OPTICAL FIBER DIGITAL CHANNEL SYSTEM

ABRAMOV, V. V., ARION, I. S., ZHABOTINSKIY, M. Ye., KITAYEV, A. Ye.,
SOKOLOV, A. V., SOSNIN, V. P. and FRANTSESSON, A. V.

[Abstract] A description is given of a ring-type optical fiber system
designed for transmitting information in digital form between 10 sources
and receivers of signals. A ring structure makes it possible to reduce
to a minimum the number of optical transmitters and receivers and the length
of connecting optical cables. In addition, organization of the system's
operation is considerably simplified, its adaptability for executing various
communications tasks is increased and fuller use is made of the carrying
capacity of channels. The ring structure is distinguished by the decentrali-
zation of multiplexing, separating and switching equipment. A system is
suggested which includes a single receiving-and-transmitting control unit
and nine receiving-and-transmitting units interconnected by segments of
optical fiber cables. Information is disseminated in a single direction
and the system utilizes time-division multiplexing with the assignment to
each station of a time interval for transmitting information. The control
unit forms a frame of eight 10-bit words and is in charge of organizing
communications and synchronization. The control unit generates a train of
synchronizing pulses 50 ns long which are grouped into frames. Each frame
contains eight synchronizing pulses separated by equal intervals with an
interval between frames equal to 100 ns. Each receiving-and-transmitting
unit including the control unit time-selects the pulses propagated through
the ring. After each recognition of a synchronizing pulse it is regenerated
and 100-ns time intervals start to be read. Each unit transmits its in-
formation only during the time interval assigned to it after each synchronizing
pulse. As each synchronizing pulse is propagated through the ring informa-
tion appears from each receiving-and-transmitting unit and a word is formed.

The first bits of information from the bytes entered into each unit are
arranged in the first frame in the first word, the second bits in the second
word, etc. When information is received by each unit the bit of the first
word received is entered into the first position of the data output unit,
the bit of the second word received into the second, etc. Each unit sends
its information into the system from which it can be withdrawn by any other
unit or by all together. Figures 3; references 3: 1 Russian, 2 Western.
[217-8831]

OPTICAL FIBERS AND OPTICAL FIBER CABLES

PROKHOROV, A. M., academician, USSR Academy of Sciences

[Abstract] A summary is given of successes achieved and problems faced in
the creation of optical fibers and optical fiber cables. The core and
sheath of light guides developed and used with the greatest success at the
present time are made of quartz glass doped in various combinations with
Ge, P, B and F. The various types of light guides produced by industry are
discussed briefly, including multimode light guides with a gradient refrac-
tive index profile, multimode light guides with a step-type refractive index
profile, and single-mode light guides. The second type is considered quite
promising for intrasystem communications lines in combination with light-
emitting diodes. In light guides based on quartz glass the regions of
minimum optical losses and the maximum transmission band almost agree,
making the 1.3 to 1.6 micrometer waveband very promising for use in wide-
band long-distance optical fiber communications. A brief description is
given of the various technologies used in the manufacture of optical fibers,
all of which are based on the deposition of layers of quartz glass from the
gas phase. These technologies include the method of chemical deposition
from the gas phase inside a quartz glass supporting tube, the method of
external chemical deposition from the gas phase onto the side surface of
a cylindrical support, and the method of axial deposition onto the face of
a quartz glass seeding rod. The last method is the only potentially con-
tinuous method of fabricating stock for light guides. Problems faced in-
clude reducing the cost of optical fiber cables by totally automating the
technological process; creating radiation-resistant optical fibers; the
creation of high-strength optical fibers; and the creation of single-mode
optical fibers which will support linear polarization of transmitted
radiation. A promising way to solve the last problem is to use light
guides with an elliptical core. There have been no published data on the
creation of infrared light guides with low attenuation levels but extensive
research is being done along this line. The main problem in the manufacture
of cables is to avoid breaking the optical fibers and the increase in opti-
cal losses during manufacture and use of the cable. Microbends in optical

fibers are a main source of increased optical losses. It is believed that
the basic difficulties along the road to creating optical fibers and opti-
cal fiber cables with specific parameters have been overcome at the present
time.
[217-8831]

LAYING OPTICAL CABLE IN URBAN TELEPHONE CABLE SYSTEM

GOL'DFARB, I. S., PROSHAY, L. L., SMIRNOV, V. I., FILIMONOV, V. P. and
CHERTOV, V. G.

[Abstract] A procedure is suggested for preparing an optical fiber cable
for laying in an urban telephone cable system, and for laying it, along
with the results of a final measurement of attenuation. The procedure was
tested in the Moscow and Gor'kiy telephone cable systems, with 28 sections
of cable with end-to-end lengths of 200 to 900 m. Cables were laid in free
and occupied ducts manually in a single direction. The spool with the cable
was placed on special trestles. The cable was advanced at a rate of not
greater than 0.5 m/s and the longitudinal force applied when drawing cable
with densely packed fibers was not greater than 200 N and 400 N with loosely
packed fibers. When being laid in cable manholes the cables were laid
onto brackets with observance of the permissible bending radius and were
fastened to fixtures at their end points. Elastic separators were placed
between the cable and supporting structures. Specially designed cable lugs
are described which are designed for laying optical fiber cables without
damaging them. A cable connector is fastened by means of screws to the
cable's outer sheath and the lug is fastened to the flange of this connector.
The lug is designed to accommodate a drawing cable. The reinforcing strands
of the optical fiber cable are fastened to the lug assembly. Measurements
of attenuation demonstrated that the presence of microcracks in an optical
fiber cable prior to laying it considerably increases attenuation after
the cable has been laid. Figures 6; references: 2 Russian.
[217-8831]

LIMITING SPEEDS FOR TRANSMISSION OF DATA THROUGH FIBER LIGHT GUIDES

BELANOV, A. S. and DIANOV, Ye. M.

[Abstract] A study is presented of the transmission characteristics of single-mode light guides whose dispersion and energy characteristics were studied in previous papers by the authors (1976-1979). The influence of dispersion of the first order on transmission of a signal is discussed. On the basis of theoretical and experimental results it is concluded that it is possible for material and waveguide dispersion to compensate one another. In order to realize this, when working with radiation sources whose wavelength is less than 1.27 to 1.30 micrometers, when positive material dispersion is observed, it is necessary to operate in the region of values of parameter V with which waveguide dispersion is negative, where $V = 2\pi a \sqrt{n_1^2 - n_2^2}/\lambda$, where n_1 and n_2 represent the refractive indexes of the core and sheath, respectively, of the light guide. It is also demonstrated that 3-layer light guides with $n_1 > n_3 > n_2$ can make possible total compensation of material dispersion of the first order over the entire range of wavelengths employed. Material dispersion of the first order was calculated for pure quartz, quartz heavily doped with germanium and quartz doped with boron. The results are given of a study of the propagation of a real Gaussian pulse in a regular waveguide taking into account the spectral line width of the radiation source. An expression is derived for determining the optimum duration of input pulses with which the duration of output pulses will be minimum and the data transmission speed will consequently be maximum. A study is presented of the influence of dispersion of the second order on transmission of the signal for the case when total dispersion of the first order equals zero. For this case stretching of the Gaussian pulse is calculated and expressions are derived for the optimum duration of this pulse with which the length of the output pulse will be minimum and the data transmission speed will consequently be maximum. Under the conditions cited, for sources with a spectral line width of less than 0.8 nm data transmission speeds of up to 100 Gbits/s are achievable for transmission over a distance of 100 km. Figures 11; references 15: 12 Russian, 3 Western.
[217-8831]

HIGH-SPEED REPEATER OF PULSE SIGNALS OF OPTICAL FIBER COMMUNICATIONS LINE

AKSENOV, Ye. A., LOGGINOV, A. S. and RZHEVKIN, K. S.

[Abstract] A description is given of an optical signal repeater which
corrects a light pulse by simultaneously restoring its amplitude and
duration with a data transmission speed of greater than 1 Gbits/s.
High-speed repeaters are required for optical fiber communications lines
of great length in order to solve the problem of regular restoration of
the parameters of the transmitted signal, which is affected by attenuation
in the fiber and by dispersion which results in broadening of the light
pulse propagated through the fiber. The repeater is based on a high-
speed threshold element in the form of a controlled Gunn diode. The
Gunn diode is triggered by a signal originating in a photodetector when
the light pulse propagated through the fiber reaches it. An injection laser
is excited by means of pulses of fixed amplitude and duration generated by
the Gunn diode. In the starting state, in the absence of a trigger pulse,
fixed voltage is established between the cathode and anode of the Gunn
diode, which creates a field of approximately 3.2 kV/cm, whereby a certain
current flows through the Gunn diode. A negative-voltage trigger pulse
arrives at the Gunn diode's control electrode and increases the resistance
of the depletion region beneath the contact, as a result of which the
field under the contact increases and with an increase above the critical
value a domain begins to form under it. The formation of this domain re-
sults in reduction in current flowing through the Gunn diode. It is
necessary to use a Gunn diode with the length of the active region $\ell \geq 10^{-2}$ cm.
The maximum power gain of the repeater is determined by the ratio of the
light power added to the fiber as the result of repeating to the minimum
light power necessary for triggering the Gunn diode with the threshold
trigger voltage. Experiments have been conducted which confirm the work-
ability of the suggested repeater. The repeater is well suited for inte-
grated design. Figures 3; references 7: 2 Russian, 5 Western.
[217-8831]

DUPLEX TRANSMISSION OF DATA THROUGH SINGLE-FIBER OPTICAL CHANNELS

BOBROV, Ye. S., DAVIDOVSKIY, S. V. and TAFEYEV, O. A.

[Abstract] The two-way transmission of data through a single light guide
makes it possible to increase the utilization of the wideband properties
of an optical fiber. An illustration is given of a single-fiber communica-
tions line in general form; in a line of this type there must be a unit
for uniting and separating the receiving and transmitting channels and this
unit can be either optical, electronic or electrooptical. A summary is
presented of the various methods of reversible uniting of optical informa-
tion. It is demonstrated that taking into account the state of the art
of existing components the simplest way to construct a single-fiber line
is a circuit utilizing directional couplers and electronic controlled
rectifiers. The basic specifications for a coupler are low attenuation in
the direct transmission channel and high crosstalk attenuation. Ideally,
in a coupler with a power division factor of two attenuation equals 3 dB,
and in order to make possible an attenuation span of 10 dB and a signal-to-
noise ratio in the receiver's output of 30 dB, attenuation in a coupler
from the transmission channel to the receiving channel must be greater
than 46 dB. Even with relatively small attenuation spans specifications
for the suppression of crosstalk are high. It is therefore necessary to
take additional measures in single-fiber channels to increase the immunity
of the receiver from the signal of its own transmitter. This is done by
installing controlled rectifiers in the input of the receiver and output
of the transmitter. It is recommended that an electrical rectifier be
installed in the photodetector unit as a compromise in the absence of
suitable electrooptical rectifiers. A circuit is presented illustrating
implementation of this solution. A user's optical fiber communications
line was developed according to the circuit suggested. It has a transmis-
sion speed of 153 Kbits/s with three pulses in a group. The photodetector's
sensitivity is 57 dB·mho and a laser diode is used as a radiating element.
The mean power introduced into the fiber is 17 dB·mho and the attenuation
span in the fiber is 20 dB. This communications channel was compared with
a 2-fiber circuit and no worsening of the subjective perception of informa-
tion was observed. The proper establishment of the phase relationships of
signals in the optical fiber cable is critical in an optical fiber communi-
cations line. Figures 7; references 16: 9 Russian, 7 Western (4 in
translation).
[217-8831]

LINE SECTION EQUIPMENT OF OPTICAL FIBER COMMUNICATIONS LINES FOR SPEED
OF 2.048 Mbit/s

MURADYAN, A. G., ZARKEVICH, Ye. A., MAKEYEV, O. N., USTINOV, S. A. and
GRAFUTKO, B. V.

[Abstract] A description is given of the line section equipment of an
optical fiber communications line which has passed bench and line tests and
is now in experimental operation in urban telephone systems. The probability
of error in the line section's output is not worse than 10^{-9} with total
attenuation of optical power on the order of 45 dB. The line section terminal
and intermediate equipment is designed for setting up interexchange and
intercenter connecting lines for an urban telephone system and also serves
as an independent channel for transmitting digital information at a trans-
mission speed of 2.048 Mbit/s. This equipment includes transmitting and
photodetection equipment, code converters, station and intermediate opti-
cal regenerators and also auxiliary communications units, remote control
units, and units for signaling and remote powering. A bipulse signal is
used as the line signal, which makes it possible to mimimize intersymbol
interference and to eliminate problems associated with compensating fluctua-
tions of the direct component. Some power gain is also achieved as compared
with the codes used in pulse code modulation channel-forming equipment with
the same noise immunity. The key elements of the line section equipment
are quantum-electronic transmitting and receiving modules making it possible
to convert electrical signals into optical and vice-versa and to realize
complete optical matching with the optical fiber line cable and electri-
cal matching with code conversion circuits and electronic regenerators.
A laser diode is used as a radiation source in the transmitter. The
radiated power from the ttansmitter can be monitored directly by means of
a remote control system, which makes it possible to locate a malfunctioning
segment of the line section. The transmitter operates at a wavelength of
0.85 micrometer and has a power requirement of not greater than 300 mA with
supply voltage of 5 V $\pm$ 10 percent. A silicon pin photodiode is used in the
receiver module. The photocurrent is amplified by means of a low-noise
input stage with high input impedance. The receiver's sensitivity with a
signal-to-noise ratio in its output of 24 dB is $5 \cdot 10^{-7}$ W and the signal
level in its output with input power of $5 \cdot 10^{-7}$ W is 0.7 V. The receiver has
a power requirement of not less than 50 mA with power supply voltage of
$\pm$ 6 V $\pm$ 10 percent. A structural diagram is presented of a transmission
line using IKM-30 (pulse code modulation) channel-forming equipment. The
line section is made up of terminal equipment, intermediate equipment and
optical fiber equipment with separable and inseparable optical connections.
The operation of all components is discussed in considerable detail.
Figures 7; references: 4 Russian.
[217-8831]

TV SIGNAL TRANSMISSION METHOD USING ADDITIONAL DIGITIZATION

BEZRUKOV, V. N. and ZHDANOV, V. V.

[Abstract] The development of solid state memories which can store several
frames has made it possible to build systems using additional signal digi-
tization in order to expand the capacity of existing TV channels. The
features and shortcomings of a number of methods are discussed, including
transforming the signal into a series of samples through multiplication by
a periodic function $F_i(t)$, alternating the signals carrying separate pro-
grams in groups of signal elements, approximating the TV signals using
Taylor's formula for a function of several variables, serial transmission
methods with the orientation and form of the samples depending upon the
information properties of the TV signals, and methods in which the components
of Taylor's formula are transmitted directly. These methods can be used
to multiplex several black and white or color programs over a single channel,
or to reduce the bandwidth of a single channel. In both cases a substantial
increase is achieved in the utilization of existing channels, while retain-
ing good transmission quality. References 10: 8 Russian, 1 Western and
1 Japanese in translation.
[237-6508]

STRUCTURE OF AUTOMATED TELEVISION TRANSMISSION NETWORK

DERYUGIN, N. G.

[Abstract] Automated television transmission networks are based on automated
TV transmission stations, automated TV relays which receive their signal
via radio or cable and automated radio broadcast stations which operate
unattended. Automated TV networks are structured along administrative and
territorial lines, with some central facilities being manned by highly
qualified personnel and other centers being controlled remotely. Remote
controlled stations are equipped with a full range of monitoring gear. Of
particular importance is the introduction of remote control and quality
control for transmission facilities located in remote regions, and providing
automated TV transmission sectors in areas with low population density.
An experimental remote controlled network has been put into operation in
Volgogradskaya Oblast'. Figures 4; references: 2 Russian.
[237-6508]

TRANSMISSION OF ANALOG SIGNALS THROUGH OPTICAL FIBER COMMUNICATIONS LINES

KALMYKOV, I. V., KUDRYASHOV, O. V., LOMANOV, V. G., PAK, G. T.,
PROKHOROV, A. M., SISAKYAN, I. N., STEL'MAKH, M. F. and SHVEYKIN, V. I.

[Abstract] A description is given of an experimental example of the trans-
mission of a SECAM color television signal created at the Physics Institute,
USSR Academy of Sciences, as an example of the possibility of creating
systems for the transmission of analog signals through optical fiber communi-
cations lines. From the TV transmitter a video signal with a spectrum width
of 6 MHz and a frequency-modulated audio subcarrier with a center frequency
of 6.5 MHz are fed through a mixer to a pumping amplifier which modulates
the intensity of the radiation. The radiation is introduced into a light
conductor by means of an optical connector. At the receiving end the signal
is picked up by a photodetector and is fed through a receiving amplifier to
a video amplifier and the audio subcarrier is fed through a band filter with
a center frequency of 6.5 MHz to the TV receiver's audio intermediate-
frequency amplifier. The receiving amplifier is constructed from series
175 integrated microcircuits. A 1NT251 transistor matrix is used for the
pumping amplifier. Two forms of radiators were used as radiation sources
in the model: a continuous injection heterolaser and a GaAs light-emitting
diode. The first experimental models of continuous heterolasers based on
the AlAs-GaAs system have been created by industry and have a minimum mean
time between failures of not less than 10^4 h and a 90-percent service life
of not less than 20,000 h. The injection heterolaser used in the model is
based on a heterostructure of the $nAl_{0.35}Ga_{0.65}As-pAl_{0.07}Ga_{0.13}As-pAl_{0.35}$-
-$Ga_{0.65}As$ type grown on a gallium arsenide substrate doped with silicon and
having dislocation density of not greater than 10^3 cm^{-2}. Design-wise the
heterolaser's active element is in the form of a small mesa with overall
dimensions of 250 X 100 X 400 micrometers. High-frequency channels are
suppressed because of the insufficient speed of response of the photo-
detector used. It is concluded that with the element base mastered by
industry it is possible at this time to create systems for the analog
transmission of TV signals with a frequency up to 50 MHz. Figures 5;
references 4: 3 Russian, 1 Western.
[217-8831]

SINGLE-MODE FIBER LIGHT GUIDES

GRIGOR'YANTS, V. V., ZHABOTINSKIY, M. Ye., DETINICH, V. A.,
ZAMYATIN, A. A., IVANOV, G. A., KORENEVA, N. A. and MERTSALOV, S. A.

[Abstract] A technology is described for fabricating single-mode fiber
light guides with low attenuation and high birefringence on account of the
formation of an asymmetric borosilicate sheath. It has been demonstrated
experimentally that these light guides maintain well the polarization of
the transmitted light and are suitable for use in optical fiber interferometers.
Since the doping impurity which causes the greatest birefringence in single-
mode fiber light guides is boron, a light-reflecting borosilicate sheath
is formed by the deposition of glass 600 to 800 microns thick with combined
oxidation of $SiCl_4$ and BBr_3. The UIZS-1 automated unit is used for this
purpose. The light-conducting layer is formed by the deposition of a thin
layer of pure quartz glass, as the most optimum procedure. In depositing
a thin layer of SiO_2 the rate of admission of $SiCl_4$ is reduced and the total
flow of oxygen is increased to 90 to 100 liters/h and a gas stream divider
is employed, making it possible to feed about 1/4 of the vapor-gas mixture
into the support tube. For the purpose of forming an elliptical light-
reflecting sheath the stock is ground on two opposite sides until the light-
reflecting sheath is exposed and then it is pulled. As the result of surface
tension the fiber is rounded on the outside and the sheath becomes ellipsoidal.
A method has also been developed for fabricating light guide stock in which
the "figured" light-reflecting sheath is formed directly in the process of
fabricating the stock for a light guide with a round cross section. The
difference between the refractive indexes of the core and sheath usually
equals $(4 \text{ to } 6) \cdot 10^{-3}$ and the outside diameter of samples of single-mode
fiber light guides is in the range of 100 to 120 micrometer with a core
diameter of 4 to 7 micrometer. Light guides with a cutoff wavelength of
0.63 micron and 0.85 to 0.9 micron have been made. Experimental apparatus
is described which is used for studying the polarization properties of
single-mode fiber light guides. It utilizes an He-Ne laser as a light
source and a quarter-wave plate and polarizer for producing light with the
required direction of linear polarization. A polarizer or Wollaston
polarizing prism spatially separating components with orthogonal polariza-
tion is used as an analyzer for the polarization state of the output radia-
tion and silicon photodiodes are used as photodetectors. An electronic
circuit makes it possible to determine the degree of polarization and a
magnetic field is created which modulates the state of polarization at the
point of its application. Figures 7; references 14: 1 Russian, 13 Western.
[217-8831]

LOSSES IN MICROBENDS IN OPTICAL FIBERS OF GLASS-POLYMER TYPE WITH LOOSELY
FITTING ABSORBING SHEATH

FEL'D, S. Ya.

[Abstract] Fiber light guides with a glass light-conducting core and a
polymer light-reflecting sheath are widely used in communications lines
of relatively short length. A theoretical discussion is presented of the
mechanism of losses in microbends in light guides of this type and estimates
are made of additional losses caused by the influence of nonideality of
the material of the light-reflecting sheath. Effects originating with the
existence of a gap between the core and polymer sheath are also discussed.
A study is made of the statistical characteristics of irregularities
occurring in glass-polymer light guides. Light guides with both a tight
and loose arrangement of the core in the sheath with an asymmetric gap are
discussed. The propagation of radiation is discussed in an irregular light
guide formed from a glass core with a round cross section with a diameter
of $2a$ and a refractive index of n_1, surrounded, tightly or with a gap, by
a polymer sheath with a refractive index of n_2, whose thickness is suffi-
cient for the effective reflection of rays propagated at grazing angles,
α, less than the critical. Losses in the material of the core are assumed
to be negligibly small. For studying losses in microbends a differential
equation is employed which describes the diffusion of rays in terms of
angle α in an irregular light guide with a stepped refractive index profile.
In order to take into account the influence of losses in the sheath's
material a term is added to this equation which takes into account the
presence of differential mode attenuation in a regular light guide, i.e.,
describing the reduction in the number of rays with angle α as the result
of absorption in the sheath. An equation is derived which takes into
account the unknown attenuation factor, σ, of the so-called statistical
mode. It is demonstrated that it is possible to estimate from the results
of measuring losses in microbends in a glass polymer light guide of the
usual design, i.e., with no gap, the possible reduction in losses in micro-
bends when a gap is created between the core and sheath. Calculated rela-
tionships are obtained between losses in microbends and a parameter de-
scribing the statistical properties of irregularities and a parameter charac-
terizing losses in the material of the sheath. A determination is made of
with what relationships between experimentally determined values of losses
in microbends and losses in the sheath's material the thermal component of
microbend losses is important. It is demonstrated that by measuring losses
in microbends it is possible to determine the statistical distribution of
microbends. Figures 3; references 13: 4 Russian, 9 Western.
[217-8831]

AUTOMATION OF ALIGNMENT OF FIBER OPTIC ELEMENTS

ANDREYKO, A. V., KALMYKOV, I. V., KLEPIKOVA, N. L., KUKLIN, G. N.,
LOMANOV, V. G., SIMACHEV, N. D. and SISAKYAN, I. N.

[Abstract] The technical parameters of optical fiber communications lines
depend considerably on the precision of the operation of aligning various
fiber and integrated optic elements in relation to the optical axis when
interconnecting them. This process is highly labor intensive and it is
therefore desirable to automate it. A description is given of a model of
an automated system developed at the Physics Institute, USSR Academy of
Sciences, using a minicomputer for controlling linear and angular manipula-
tions. The system is designed in accord with the CAMAC standard and con-
sists of a video terminal, an "Elektronika-60" minicomputer with a 4K-word
memory, a crate with CAMAC modules and an aligning unit. The crate includes
a scaler, an analog-digital converter, a step motor control module, a
voltage conversion module, a controller, and a commutator for selecting the
appropriate step motor. The aligning unit is based on a 5-coordinate table
making movement possible along two horizontal coordinates, X and Y, and
axial coordinate, Z, and two angular coordinates. The linear coordinate
resolution is 1 micrometer and the angular 1.5 seconds of arc. The posi-
tion of one element to be combined is fixed and the other element, e.g.,
a fiber light guide, is fastened to the 5-coordinate table whose position
is controlled by the minicomputer. Movement takes place in the direction
of an increase in power in an output photodetector. An alighment algorithm
is presented which makes it possible to eliminate situations such as non-
optimum positioning and recycling. This algorithm takes into account the
relative position of coordinates. Information on the optical power is
entered into the minicomputer in the form of a code produced by means of
the analog-digital converter and the computer compares the data obtained
with the old data and issues a control signal to the step motor control
mdoule. The punched tape alignment program is input into the minicomputer
by means of a photoelectric reader. Figures 3.
[217-8831]

STUDY OF INTERMODE DISPERSION IN OPTICAL FIBERS BY CORRELATIONAL ANALYSIS
OF RADIATION FIELD

DEDLOVSKIY, M. M., KORSHUNOV, I. P., MATVEYEV, R. F. and
TUTUBALIN, V. N.

[Abstract] In continuation of studies of the performance of multimode
optical fibers, measurements were made of intermode dispersion and the re-
sults are now evaluated by the method of correlation analysis. A gas laser
served as a light source in the experiment with an autocorrelation function,
periodic in time its radiation field constituting a superposition of fiber
modes and the autocorrelation functions of all modes at the fiber exit
similar to the correlation function at the entrance, but shifted from one
another by time intervals proportional to their respective time lags. The
equipment included, in addition to a fiber-optics interferometer and a Ne-
He laser operating in the TEM_{00}-mode, three light-splitting mirrors, a
plane-parallel plate, a microobjective, three objectives, a plane fixed
mirror, a plane sliding mirror, a quarter-wave plate, a polarization analy-
zer, a photo-receiver, a diaphragm, a buffer amplifier, a constant-component
filter, a selective amplifier with square-law detector, and an XY-plotter.
In the theoretical part a relation is established between the luminosity
function and the amplitude-frequency characteristic of a multimode fiber,
assuming the amplitude-frequency characteristic to be determined by inter-
mode dispersion only. The field intensity distributions over the cross
section of the reference beam and over the fiber exit section as well as
the luminosity function of the interference pattern are first assumed to
be known at each point of the fiber section and then treated probabilisti-
cally on the basis of random distributions. The results are applied to a
two-layer fiber, specifically the 800 mm long GRADAN multimode fiber
actually tested. The authors thank V. V. Grigor'yants and G. A. Ivanov for
supplying the fiber specimens, Ye. N. Korshunova and T. V. Selezneva for
calculating the pulse response, B. G. Klevitskiy for assisting with measure-
ments, also V. P. Vard'ye and A. D. Shatrov for helpful discussions and
valuable suggestions. Figures 5; references 11: 7 Russian, 4 Western.
[199-2415]

COMPONENTS OF OPTICAL FIBER COMMUNICATIONS LINES

STEL'MAKH, M. F.

[Abstract] The state of the development and manufacture of the key components
of optical fiber communications lines is discussed, including radiators,
receivers, transmitting and receiving modules and integrated optical de-
vices. The present stage of the development of optical fiber communica-
tions lines is characterized by the development of components for the short-
wave and longwave bands, i.e., 0.8 to 0.9 micrometer and 1.1 to 1.7 micrometer.
Existing radiators based on ternary solid solutions of the (AlGa)As type
operating in the 0.8 to 0.9 micrometer band and silicon receivers utilizing
pin diodes do not conform to the optimum wavelengths for a quartz optical
fiber with regard to minimum dispersion and attenuation. The main develop-
ment work on various types of optical fiber communications lines is being
done with components for the shortwave band, because the technology for this
band is better developed. These components are used in relatively short
lines, such as in intrasystem and local communications lines. Soviet
scientists were the first to demonstrate that radiation sources for the
longwave band can be created from 4-component solid solutions of the
InGaAsP type, and receivers using structures of the InGaAsSb type have been
created for this band. The problem of obtaining high-quality materials and
structures is still being faced in this case, however. Semiconductor
radiation sources utilizing heterostructures are the most widely used at the
present time in optical fiber communications lines. The three basic types
are discussed: light-emitting diodes, superluminescent radiators and semi-
conductor lasers. A so-called superluminescent diode has been developed for
optical communications purposes, based on a laser heterostructure in the
AlAs-GaAs system. The greatest achievement in recent years in the area of
semiconductor lasers for the shortwave band has been the development of
lasers with a minimum mean time between failures of 10,000 h. The main
trend in improving the fundamental characteristics of semiconductor lasers
has been to reduce the size of the laser's active region. The optical fiber
used at the present time has minimum attenuation and dispersion in the 1.1
to 1.7 micrometer waveband and lasers have been produced for this band by
employing double heterostructures in which the emitters are made of indium
phosphide and the active region of the quaternary solution InGaAsP. Silicon-
based avalanche photodiodes and pin photodiodes satisfy the requirements for
photodetectors in the 0.8 to 0.9 micrometer band. Development work is under
way on injection lasers with distributed Bragg reflectors, semiconductor
lasers with an external resonator and aluminum-yttrium garnet lasers with
neodymium and light-emitting diode pumping. Work on the integration of
optoelectronic devices is being done along three major lines: the creation
of monolithic integrated circuits employing semiconductor substrates, such
as a laser-modulator, laser-transistor, laser-photodetector; the creation of

monolithic integrated circuits utilizing ferroelectric substrates, such as an electrooptical directional coupler and a modulator with a lithium niobate interferometer; and the creation of hybrid integrated circuits employing "support" substrates. Figures 12; references 18: 13 Russian, 5 Western. [217-8831]

OPTICAL SYSTEMS FOR RECORDING AND REPRODUCING VIDEO DATA

TAKEDA, Ya.

[Abstract] The two existing methods of recording and reproducing two-dimensional video data with a laser beam, directly by sequential in time coding of FM signals and holographically by sequential recording of image frames, are reviewed and compared. Both methods involve a tradeoff to ensure a sufficiently high signal-to-noise ratio without excessive complexity of the tracking system. The state of the art includes use of rotating video disks with a helium-neon laser or less costly laser diodes. Second-generation and third-generation equipment includes cyclic memories with erasure and transcription. Latest trends in thermomagnetic recording and optical counting on film as well as in film materials and technology are already set for the coming decade. Figures 15; references: 26 Western. [203-2415]

INSTRUMENT FOR DETERMINING POINT OF DAMAGE IN OPTICAL FIBER CABLE WITH DIGITAL READOUT OF DISTANCE

OLEYNIKOV, A. D., PERSHAKOV, V. V., ROMANOV, V. S. and SKLYAROV, O. K.

[Abstract] A description is given of an instrument employing the pulse method of location and designed for determining the point of damage in an optical cable during its production, installation and use in communications lines. This is a portable bench-type instrument. An oscillograph can be connected to it for observing the full pattern of reflections in the optical fiber cable, which makes it possible to make general estimates of the cable's quality. A quartz oscillator generates 1-MHz sinusoidal voltage and forms from it square pulses which are fed to two channels: a 1 : 100 divider and a normally closed electronic switch. From the 1 : 100 divider the pulses

are sent to an open switch, after which they are sent to a modulator and a controlled delay unit. Pulses 10 ns long, amplified and shaped by the modulator, modulate a semiconductor oscillator which generates short light pulses which are fed through an optical splitter to the input of the optical cable being studied. The optical signal passes through the optical cable to the point of damage and is reflected from it and returns to the optical splitter and enters a photodetector in which the light pulses are converted into electrical signals, are amplified and fed to one of the inputs of a coincidence circuit. Pulses delayed by the controlled delay line enter the other input of the coincidence circuit and a light-emitting diode in the coincidence readout circuit lights up when the pulses arriving at the coincidence circuit's inputs coincide. The operator then opens a third normally closed switch and the signal travels from the coincidence circuit to the modulator and controlled delay unit and the signal is recycled with a cycle strictly related to the distance to the point of damage in the optical cable. Time measuring units then begin to count the pulses from the quartz oscillator and the recycling cycles. After the result is read out for a time sufficient for the operator to read it, the units are automatically switched back to the original state and the measuring process is repeated. The accuracy of measuring a point of damage in a cable up to 1 km long is ± 1 m and the instrument's overall dimensions are 480 X 300 X X 150 mm and it weighs about 10 kg. Figures 4.
[217-8831]

OPERATING FEATURES OF 'IL'MEN' TELEVISION RADIO STATION

SHAPKOV, F. N., senior engineer, Rezekne Radio-Television Transmitting Station, and KIRILLOV, N. G., senior engineer

[Abstract] The first of the new series "Il'men" band-IV television radio station has operated in Rezekne (LaSSR) since 1979 and has already accumulated 12,000 h transmitting time. Its main distinguishing features are transit-time klystrons in the output stages, signal modulation at intermediate frequency, high levels of transistorization and automation. Klystron amplifiers in both video channel and audio channel are preferable to traveling-wave tubes because of their better performance characteristics, particularly wider range of linearity. Appropriate measures have been taken in order to ensure adequate stability of these devices and adequate reliability of other critical station components such as high-frequency commutation, power compounding, phasing and demodulation. Major deficiencies were found to be poor soldered joints in the low-power stages and excessive heating inside equipment cabinets. Weak spots were also found in the power supply equipment and antenna-feeder equipment. Tubular feeders (160 mm diameter) have been replaced with VAKhA 75-120D cables (imports). The station complex includes now also "Yakhont-A" test and measuring equipment for inspection of picture and sound tracks. However, the station still needs more alternate

and standby capacity. Nevertheless, after corrections and adjustments have
been made the station has already been operating reliably for 1050 h.
Figures 3; tables 1.
[198-2415]

CREATING OPTICAL CONNECTORS

MAKOVETS, G. K. and POKROVSKIY, V. R.

[Abstract] The practical introduction of optical fiber data transmission
lines has been impeded by the lack of the mass production of optical connec-
tors. Optical connectors for broad industrial applications must meet the
following key requirements: They must not have to be aligned when in use;
they must have low attenuation of less than 0.5 to 1 dB; they must not re-
quire complicated equipment for installing them on cables; and the cable
termination must be strong in order to ensure reliable performance and pro-
tection of the glass fiber. The designs of connectors most often used in
Soviet optical fiber data transmission lines represent a compromise engineer-
ing solution, whereby the connector cannot be aligned when in use but is
aligned when terminating the cable. This makes it possible to eliminate
deviation in the geometrical parameters of single fibers and the error
associated with the tolerance for machining parts of the connector. An
illustration is given of an optical connector developed for connecting seg-
ments of single-fiber cables with a 60-micron diameter of the fiber's
light-conducting cross section. This connector is in the form of a sleeve
with grips at its ends. The inside surface of the sleeve, 5 to 6 mm long,
has a 3- to 5-micrometer high-precision finish. The cable lugs are in the
form of sleeves on which thrust collars have been fitted. The sleeve and
collars are made of steel in order to increase wear resistance in repeated
connection and disconnection. The lugs are tightened by means of collet
nuts when the connection is made. When terminating the cable, the face end
of the lug is ground and polished and cross-shaped alignment marks are made
on it by means of a special micro marking gauge with a distance of 50 microm-
eters between the marks. Perpendicularity is made possible by a special
collet clamp. The prepared end of the cable is inserted into the lug which
has first been filled with an epoxy compound, so that the end of the fiber
projects 0.5 mm from the opening. The lug is then inserted into the hole of
the table of the unit for terminating the cable and is fixed with a clamp.
A transparent film is placed on the projecting end of the single fiber
perpendicular to the axis of the fiber and by moving the film under a micro-
scope over the alignment marks it is possible to align the single fiber co-
axially with the lug. The face end of the lug is ground and polished after
the epoxy compound hardens. This termination process makes it possible to

align the fiber's axis with accuracy of 4 to 7 micrometers. The process
of inserting the lug has been simplified. The fiber is inserted without
centering and the resulting eccentricity is eliminated by final machining
of the outside cylindrical surface of the thrust collar on the terminated
cable. The terminated end of the cable is inserted into the clamp of a unit
with a rotating cutter whose axis of rotation is in line with the axis of
the light-conducting cross section of the fiber. Then the external cylindri-
cal surface of the collar is machined by means of the cutter. This technique
makes it possible to lower specifications for the precision of the fabrica-
tion of individual units and parts and eliminates the influence of eccentri-
city of the light-conducting core relative to the outside surface of the
single fiber. Figures 2.
[217-8831]

STATISTICAL ANALYSIS OF DIGITAL FIRST-ORDER PHASE-LOCKING SYSTEM WITH
NONUNIFORM REGULATION INTERVAL

SHAKHGIL'DYAN, V. V., BURDZEYKO, B. P. and AKIMOV, V. N.

[Abstract] Digital first-order automatic frequency trimming systems with
phase control and constant or variable regulation interval are analyzed
statistically on the basis of recurrence relations for a structure consist-
ing of a reference generator with adder-subtractor and frequency divider.
The phase detector in the control loop is assumed to have a relay charac-
teristic, at its second input a rectangular signal mixed with additive
noise is assumed to appear, and the digital low-pass filter in series with
it is disregarded here. Nonuniformity of the regulation interval is taken
into account by not assuming a very large frequency divisor. Certain proper-
ties of applicable Markov chains are revealed by this analysis and are
demonstrated on numerical examples. Asymptotic distributions are obtained
for the case of a nonzero initial frequency mismatch. The conditions of
pullout are determined according to the model of random walk along a circle.
The authors thank M. A. Mironov for interest in this study and discussion
of its results. Figures 4; references 10: 9 Russian, 1 Western.
[199-2415]

AUTOMATIC TRACKING DISTORTION CORRECTOR WITH REFLECTION OF DIGITAL TV
CHANNEL FREQUENCY CHARACTERISTICS

RADIKAYNEN, Ya. I.

[Abstract] In 1980 the author described an automatic tracking corrector
of TV channels, which transmits analogous signals. In the present work he
considers the circuit of an automatic tracking corrector for a digital TV
channel. A block diagram of the device is presented and its operation in
a correction mode with reflection of the frequency characteristic is de-
scribed. The rate of convergence of the algorithm of the device is
determined. Figures 3; references: 3 Russian.
[159-6415]

EFFECT OF THREE DIMENSIONALITY DURING OBSERVATION OF TWO-DIMENSIONAL
IMAGES

DUKLAU, V. V., KOPYLOV, P. M., POLYANSKIY, Yu. G. and UKRAINSKIY, O. V.,
Leningrad Electrical Engineering Communications Institute

[Abstract] It is shown that: 1) Monocular vision can be used for obtaining
depth of TV images. However, comfort is observing the images is insuffi-
cient; 2) During observation of moving images, an appreciable stereo effect
can be obtained with binocular observation of plane TV images if their
brightness is considerably reduced for one eye; 3) It is possible to obtain
the illusion of three dimensionality during observation of static plane
images if their linear dimensions for both eyes differ by 10-20%; 4) In
order to obtain the illusion of three dimensionality during observation of
stationary and moving plane TV images, simultaneous realitzation of the
conditions stated in point 2 and 3 above is recommended; and 5) In some
stereoscopic TV systems with insufficient depth of relief, a decrease of
brightness of one of the images of the stereo pair can also be used.
Figures 3; references 7: 5 Russian, 2 Western.
[159-6415]

ADAPTIVE RECURSIVE FILTER FOR COMPLEX SIGNALS

Moscow OTKRYTIYA, IZOBRETENIYA, PROMYSHLENNYYE OBRAZTSY, TOVARNYYE ZNAKI in Russian
No 46, Dec 81 p 283-284

[Translation of Patent number 890544]

[Text] An adaptive recursive device for filtering complex signals is disclosed
which contains two channels, one equiphase and the other quadrature, each of
which consists of a filter consisting of a multitap delay line with taps connected
to the inputs of four groups of weighting blocks, with the control input of each
weighting block of the first group of the filter of the equiphase channel com-
bined with the control input of the corresponding weighting block of the first
group of the quadrature-channel filter and connected through a corresponding first-
group accumulator to the output of the first-group summator, the first input of
which is connected to the output of the first-group multiplier of the equiphase-
channel filter and the second input of which is connected to the output of the
first-group multiplier of the quadrature-channel filter; the control input of each
weighting unit of the second group of the equiphase-channel filter is combined
with the control input of the corresponding second-group weighting unit of the
quadrature-channel filter and connected through the corresponding second-group
accumulator to the output of the second-group summator, the first input of which
is connected to the output of the second-group multiplier of the equiphase-channel
filter and the second input of which is connected to the output of the second-
group multiplier of the quadrature-channel filter; the outputs of the first-group
weighting units in each filter are connected to the first input of the output
summator of the corresponding channel, the second input of which is connected to
the outputs of the second-group weighting units of the filter in the other channel;
the output of each output summator is connected to the inputs of the decision unit,
the first output of which is connected to the first inputs of the first-group
multipliers of the equiphase-channel filter, the second input of each of which
is combined with the first input of the second-group multiplier of the equiphase-
channel filter and connected to the corresponding tap of the multitap delay line
of the equiphase-channel filter and to the first inputs of the second-group mul-
tipliers of the quadrature-channel filter, the second input of each of which is
combined with the first input of the first-group multiplier of the quadrature-
channel filter and connected to the corresponding tap of the multitap delay line
of the quadrature-channel filter, and a partial derivative computer consisting
of a multitap delay line to the taps of which are connected the first inputs of

63

the corresponding weighting units and the first inputs of the corresponding mul-
tipliers, the second input of each of which is connected to the output of the
decision unit, and the output of which is connected through the corresponding sum-
mator and accumulator, in series, to the control input of the weighting unit and
to the control input of the third-group weighting units of the equiphase and
quadrature channel filters. This filter is distinguished by the fact that in order
to increase signal correction accuracy, the input of the multitap delay line
in the filter of each channel is connected to an input summator, the second input
of which is connected to the outputs of the third-group weighting units of the
filter of its own channel, and the third input is connected to the outputs of the
fourth-group weighting units of the filter of the other channel; connected be-
tween the outputs of the weighting unit and the input of the multitap delay line
in each partial derivative computer is a first auxiliary summator, the other input
of which is connected to the output of the output summator of the corresponding
filter, to the output of which are connected, in series, the second auxiliary
summator and auxiliary multitap delay line, to the taps of which are connected
the corresponding auxiliary weighting units, whose outputs are connected to the
second input of the second auxiliary summator, and one of the inputs of the cor-
responding auxiliary multipliers, the other inputs of which are connected to the
second output of the decision unit; connected to the outputs of the auxiliary
multipliers of the partial derivative computers of both channels are the corres-
ponding auxiliary summator and accumulator, in series, the output of which is
connected to the control inputs of the corresponding auxiliary weighting unit
and to the control inputs of the corresponding fourth-group weighting units of
the equiphase and quadrature channel filters.

COPYRIGHT: VNIIPI, 1981

6900
CSO: 1860/220

BASIC EQUATION OF ELLIPSOMETRY FOR TEST DIFFRACTION GRATINGS APPLICABLE
DURING CHECKING OF LARGE INTEGRATED CIRCUIT STRUCTURES

LONSKIY, E. S.

[Abstract] The present work determines the parameters of large integrated
circuit structures by means of an investigation of the elements of a test
unit in the form of diffraction gratings. The gratings were produced on
a SiO_2-Si structure by means of etching into the SiO_2 of periodically
alternating grooves with a period d and a width b (nonetched bands have a
width a). An equivalent model is used of a plane grating which provides
superposition of five gratings with a period d. The coefficients of light
are shown for the five gratings. The basic equation of ellipsometry is
obtained for the equivalent model, and the errors of the approximation used
are analyzed. An equation is derived in order to determine for arbitrary
gratings of thickness of the residual oxide in the groove and the ratio of
the dimensions of the lines of the grating to its period with the aid of
measurements made in five random orders of diffraction of the ellipsometric
parameters Δ, ψ of light reflected from the gratings investigated.
References 2: 1 Russian, 1 Western in translation.
[137-A-6415]

METHOD FOR SYNTHESIZING DIGITAL FILTER-DEMODULATORS BASED ON DUAL FFT

VITYAZEV, V. V. and STEPASHKIN, A. I.

[Abstract] The simulation method is based essentially on sequential
filtering and demodulation (in the sense of extracting the complex envelope
with respect to the center frequency) of one segment of the partial group
signal, followed by frequency separation and demodulation of another seg-
ment of the components of the complex envelope of the IDH partial group
signal at a lower digitization frequency. A functional diagram of the digi-
tal filter-demodulator is presented, along with a description of the actual
implementation of such a device. Using a two-stage structure for a set
of narrow band filter-demodulators reduces the size of the data files input
to the rapid Fourier transform processors, which is a major factor in imple-
menting the devices using special large scale integration. These filter-
demodulators can be used in developing transmultiplexers. References 5:
4 Russian, 1 Western in translation.
[237-6508]

SYNTHESIS OF MICROWAVE BANDPASS FILTERS WITH ZOLOTAREV CHARACTERISTICS

[Abstract] One way to optimize filters is to design them on the basis of
Zolotarev (elliptical filters) characteristics. This article describes a
synthesis method based on using an equivalent ring circuit to implement a
Brune section. Implementation of these circuits is described, along with
an algorithm for synthesizing and tuning Zolotarev filters. Figures 4;
tables 3; references 12: 3 Russian, 9 Western (3 in translation).
[237-6508]

HYBRID MATCHED FILTERS FOR DISCRETE FREQUENCY-MODULATED SIGNALS AND THEIR NOISE TOLERANCE

ZHAYLOOBAYEV, N.

[Abstract] This article examines a promising version of hybrid digital-analog filters which can operate effectively in the presence of random structural, pulsed and narrow-band noise. As a first approximation, the noise tolerance of processors using analog linear matched filters and processors using hybrid filters can be evaluated by the change in the signals-less noise-ratio at the output of the respective filters in the presence of signal, random noise and powerful structural, pulsed and narrow-band noise at theouttput of these filters. The noise tolerance of analog matched filters and hybrid filters is analyzed and compared. It is found that hybrid filters work better with powerful structural, pulsed and narrow band noise. Figures 4; references: 5 Russian.
[237-6508]

USE OF INSTRUMENTS FOR DIAGNOSING CIRCUITS LOADED WITH WHITE NOISE IN ADJUSTING TRANSMISSION SYSTEMS

ROMBRO, V. S., OYSGEL'T, M. G. and SHKOL'NIKOV, M. B.

[Abstract] This article describes the use of white noise signals in order to find the cause and location of reduced noise protection of transmitted signals during adjustment of a signal path. The method is explained using the example of measurements made on an actual circuit by successively shortening the length of the section tested until the problem is found. Figures 7; references: 5 Russian.
[237-6508]

EFFECT OF NONLINEARITY OF SIGNAL PROCESSING ALGORITHMS ON STATISTICAL
CHARACTERISTICS OF ADAPTIVE FILTERS

MEDVEDEV, S. Yu. and POZUMENTOV, I. Ye., Gor'kiy State University

[Abstract] A stochastic differential equation is derived for the identifica-
tion error made by an adaptive signal processing filter. This equation serves
as the basis for a comparative analysis of the filter performance according
to a linear algorithm and a nonlinear algorithm respectively. The linear
algorithm is applied to typical cases of Markov fluctuations, namely
Gaussian and telegraphic ones, of the amplitude of a narrow-band random
input process. The nonlinear algorithm is applied to Gaussian fluctua-
tions with a zero mean and exponential correlation functions. The statisti-
cal characteristics, namely power of the error signal and weight-factor
adaptation time as well as probability parameters of the signal amplitude,
indicate a faster and more accurate filter adaptation but also a larger
dispersion of weight-factor fluctuations with the nonlinear algorithm.
The authors thank A. N. Malakhov for his attention and A. A. Mal'tsev for
his helpful comments. Figures 1; tables 1; references 12: 5 Russian,
7 Western.
[201-2415]

COMMUNICATIONS

USE OF 'KONTEYNER' RADIO RELAY LINK IN REGIONAL NETWORK

[Article by P. M. Medyanik, chief of State Inspectorate of Electrical Communications of Checheno-Ingushskaya ASSR PTUS]

[Text] The least reliable link in the Unified Automated Communications System today are the rural regional networks, where only one type of communications facility is used on many links (cable or overhead line). The reliability of an overhead line depends on the level of protection against mechanical damage in regions where agricultural or other excavation operations are conducted. Furthermore, the severe shortage of cable production and towers is retarding the rates of development of regional networks. Under mountainous conditions, this is aggravated by the extreme difficulty in selecting routes for cable and overhead lines.

The Production-Technical Communications Directorate (PTUS) of the Checheno-Ingushskaya ASSR began in 1976 to introduce the "Konteyner" radio relay equipment in regional networks, first as the basic type of communications, and then to increment and provide backup for existing cable or overhead lines.

Five years of experience in operating the "Konteyner" equipment under mountainous conditions have demonstrated good performance of the channels which are organized and better reliability than other types of communications.

Before this equipment began to be put in place, it was decided to concentrate the "Konteyner" within a single enterprise — the RRTPTs [expansion not given]. This made it possible to accumulate experience in operating the equipment and to train qualified specialists who know how to overcome many of the difficulties involved in setting up radio relay links and calibrating equipment under both laboratory and field conditions.

When the "Konteyner" radio relay equipment is used on intra-regional links, the interval length is between 10 and 25 km. In order to organize stable communications over such intervals, path clearance of 4-7 m is quite sufficient. This clearance can be provided with an antenna height on the order of 20-25 m. The directivity pattern of the phased antenna array used is on the order of 15-20° in both the vertical and horizontal planes. This has made it possible to use inexpensive high-voltage towers of type SK-7 of SK-4A (high voltage conical support)26 m high,

which are not particularly rigid. The mechanical strength of this support allows it to accommodate a 1.5 x 1.5 m platform on top (of the projector variety) and an antenna support in the center which enters the "Konteyner" set. An enclosed metal ladder is fastened to the side of the tower (Figure 1).

The tubular antenna support supplied for "Konteyner" repeater stations consists of two sections: the bottom section is fastened "blind" to the support, while the top section can be rotated freely. The antennas are fastened in one direction to the top part, and in the other direction to the bottom. In order to align the antennas fastened to the fixed part we have developed a special strap and flange arrangement which, when released, allows the antenna to move freely on the bottom part of the support pipe. A second antenna is also connected to this flange.
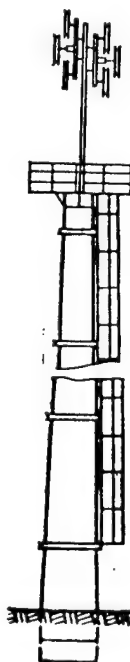
Figure 1. Construction of "Konteyner" antenna.

Figure 2. "Konteyner" equipment rack.
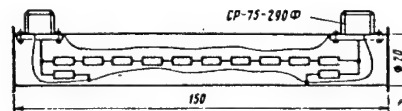
Figure 3. HF line equivalent.

The dimensions of the radio relay equipment do not correspond to the standard dimensions of line equipment room equipment; therefore, we fabricate special racks of 75 x 75 angle iron (Figure 2) which can accommodate two terminal or one inter- mediate "Konteyner" stations and a single type VB-24/6 rectifier for their power supply. Equipment held in this rack installed in a row with other equipment is convenient to service, and fits well in the line equipment shop.

The manufacturing plant usually equips the antenna feeder cable with a high frequency connector which connects the cable perpendicularly to the front panel of the antenna filter unit, which interferes with the passage of service personnel. We have replaced this connector with an elbow. The feeder cable now runs upward and is fastened to a cable rack, from where it goes on to the antenna.

In order to align the A- and B-stations radio relay and AU multiplexing equipment under laboratory conditions, an HF line equivalent was fabricated of copper tubing 20 mm in diameter and 150 mm long (Figure 3). The tubing contains an electrical attenuation circuit of ten-megohm resistors in series. This network is soldered to type SR-75-290F connectors, 75 ohm resistors are connected in parallel to the ends of the line (Figure 4) and the network is placed inside the tubing. This equivalent has 35 dB attenuation; according to laboratory tests its traveling-wave ratio is between 0.85 and 0.90 through the 390-470 MHz range (according to the technical specifications for the "Konteyner" equipment, the traveling-wave ratio of the line must be at least 0.7).

Since the signal attenuates by 70-90 dB over the propagation path, 2 to 3 such equivalents are used for laboratory testing of radio relay equipment: these are connected directly by means of cable jumpers to the antenna connectors of both radio relay stations in one interval.

According to the technical specifications for the "Konteyner" radio equipment Zh'II.105.000/002-TU, main stations are produced only with the suffix VN (with receive frequency higher than transmit frequency). If a "Konteyner" DM-400/6 or DM-400/32 with suffix NV is already in place at the location where the radio relay equipment is being installed, the new equipment can be reconfigured for the suffix NV to ensure electromagnetic compatibility. In order to do this, it is sufficient to switch the transceivers and antenna filters on the radio relay link interval between stations A and B without any changes in the structure of the equipment, levels, etc. This limitation which the technical specifications impose on the equipment is obviously unjustified, especially since repeater and terminal stations are being produced with this suffix.

Figure 4. HF line equivalent where
R1-R16 - 10 megohms; RII-R12 - 75 ohms.
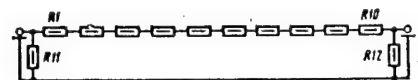
The frequency plan of the "Konteyner" equipment allows 6 routes to be organized. Since routes I and III, II and IV have incompatible image channels at a single point, only 4 routes can be organized. If the tandem junction at an oblast center requires more routes, it is possible to install "Konteyner" equipment on any 2 routes with the same pairs of frequencies at the main stations, connecting the first trunk to one route and the second trunk to the other. However, this scheme, which provides no backup, can only be used to duplicate some other link.
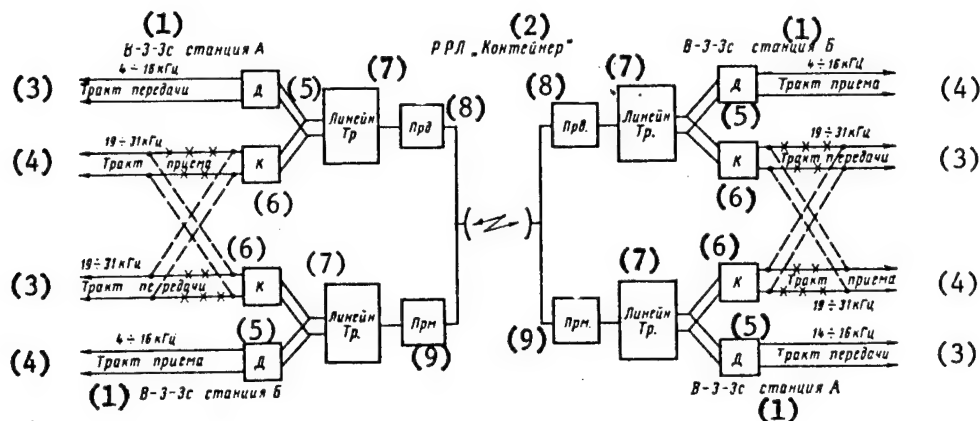
Figure 5. Connection of two V-3-3s transmission systems to a single "Konteyner" equipment trunk. Key: 1, V-3-3s station; 2, "Konteyner" radio relay link; 3, transmit circuit; 4, receive circuit; 5, [not explained]; 6, sealed reed relay; 7, line transformer; 8, transmitter; 9, receiver.

Difficulties have now arisen in the delivery of type OR-6 transmission systems: only 40% of the PTUS requirement for this equipment is being satisfied. Therefore, "Konteyner" radio relay equipment is not used at full capacity (a total of one trunk for every 6 channels) or is used without any transmission systems. In these cases, a single trunk can accommodate two type V-3-3s transmission systems, which makes it possible to obtain 6 voice grade channels (Figure 5). The psophometric noise level in the telephone channel of a two-span radio relay link multiplexed with 2 V-3-3s systems is 3 to 4 times lower than the OR-6 equipment; the cost of 4 V-3-3s racks is 5220 rubles lower than for OR-6 racks (in the version which provides 6 audio frequency channels).

If the OR-6 multiplexing equipment is placed immediately adjacent to the ATSK [Crossbar-type telephone exchange] and the impedance of the signal channel circuit is less than 1 kilohm, current on the order of 120 to 130 mA passes through the contacts of sealed-reed relay K in the SK-2 module, which causes the contacts to stick, and sometimes causes the relay to break down. In such cases, we connect additional resistance of the order of 120-390 ohms in series with the relay contact circuit. The optimal value of this current is 70-80 mA.

In the first models of the OR-6 multiplexing rack, the VTSP [expansion not given] table from the radio relay equipment was connected "hermetically". When checking the multiplexing equipment working "into itself", the cable had to be unsoldered in order to load the equipment into an equivalent. Our rationalizers installed two switches and an attenuator on the removable cover of the OR-6 rack (Figure 6). For convenience, the knobs of these switches can be connected mechanically by a jumper, or a wafer switch can be used.

The circuit of the low-frequency amplifier unit SS in the OR-6 rack provides full-time loudspeaker communications, for which the volume control only partially reduces the volume: this disturbs the work of service personnel in the shop.

In order to eliminate this effect, a switch has been installed in low frequency amplifier module SS which turns off the loudspeaker and simultaneously loads the low frequency amplifier to a 5-ohm resistor.

Figure 6.   Connection of attenuator. 1, to radio relay transmission; 2, to multiplexing equipment transmission; 3, to radio relay reception; 4, to multiplexing equipment reception.

(1) К передаче РРЛ
(2) К передаче АУ
(3) К приему РРЛ
(4) К приему АУ
R1 20 R2 24 R5 240 R3 20 R4 24
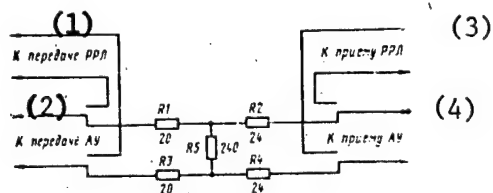
On the whole, 5 years of experience in operating this equipment has demonstrated good operating qualities.

6900
CSO: 5500/1014

DESIGN OF OPTIMUM NONLINEAR INSTRUMENTAL FOLLOWING SYSTEM ACCORDING TO
GENERALIZED QUALITY DIAGRAMS

ARSLANOV, R. A. and LIKHTTSINDER, M. Ya., Tashkent Electrical Engineering
Institute of Communication

[Abstract] A method is described for synthesis of nonlinear following
systems, optimum with respect to speed of response, on the basis of general-
ized quality diagrams. A procedure for plotting a quality diagram with two
adjustable parameters is considered. A choice is made of the parameters of
the correcting network of the following system of an automatic compensator
with a pre-amplifier. Use of the procedure described is illustrated, em-
ploying as an example a calculation of the correcting network mentioned
above. In contrast to a 1977 report of which R. A. Arslanov (see above)
was a coauthor in a solution of the problem of nonlinearity of the ampli-
fier, the mechanical characteristics of the motor and the force moment of
dry friction are taken into account. It is concluded: 1) Use of the method
of a generalized quality diagram gives the possibility of planning complex
nonlinear following systems close to optimum with respect to speed of response;
2) The results of an approximate construction of a transient process, accord-
ing to a generalized quality diagram, gives a good convergence with the re-
sults of modelling. The paper was recommended by the Department (Kafedra)
of Measurements in Communication Technology. Figures 4; references:
5 Russian.
[151-6415]

MODEL OF QUANTIZATION AND OVERLOAD NOISE SOURCE IN AUDIO FREQUENCY CHANNEL
OF DIGITAL TRANSMISSION SYSTEM

SHPIGEL', A. R. and SHCHAVINSKAYA, V. M.

[Abstract] Two noise models, one for low test signal levels and the other
for higher test signal levels, are described. The first model contains a
quantizer and an additive noise source, while the second model contains only
a quantizer. These models allow the probability distribution functions of
the instantaneous quantization and overload noise values to be examined with
test signals of various types and levels, which is necessary for investigating
the properties of voice grade channels in pulse-code modulation systems and
for developing methods and means of measuring system characteristics.
Figures 3; tables 2; references 8: 4 Russian, 4 Western in translation.
[237-6508]

IMPROVING OPERATION OF INTERCITY AUDIO BROADCAST CHANNELS

NYURENBERG, V. A.

[Abstract] An automatic compensator for stabilizing the signal gain over
intercity audio broadcast channels is described which uses the operating
principle of an inertial level limiter. This compensator can be used to
replace the compander system and preemphasis and recovery circuits at the
receiving end of the channel, thus stabilizing the normal signal level,
cutting the power at the output of the transmission system by a factor of
two, providing required noise suppression and preventing overloading of
subsequent sections. In the investigations, development and tests of the
autocompensator, an active part was taken by coworkers of laboratories of
the Scientific-Research Sector ofthe MEIS (Moscow Order of the Red Banner
of Labor Electrical Engineering Institute of Communication) E. B. Kuznetsov,
S. L. Mishenkov, A. M. Grishin, A. I. Ryazanskiy, I. M. Minayeva and
K. K. Kvashnin. Much assistance was given by workers of interurban telephone
stations. Figures 5; references: 5 Russian.
[237-6508]

SPECTRAL-CORRELATION PROPERTIES OF SIGNAL AND NOISE MIXTURE AFTER
NONLINEAR NARROW-BAND TRANSFORMATION

GOLYANITSKIY, I. A. and MALYSHKO, V. F.

[Abstract] An investigation is made of the spectral-correlation properties
of an output process and its quadrature components at the output of a unit
consisting of an inertialess nonlinearity, with the characteristic $y = g(x)$
and a band-pass filter. The filter is sufficiently wide-band so as not to
distort the process in the first spectral zone and to suppress all the re-
maining spectral zones. Figures 3; references 11: 9 Russian, 2 Western.
[88-6415]

MINIMIZATION OF MAXIMUM PEAKS OF CORRELATION FUNCTIONS OF NOISE-TYPE
SIGNALS

VARAKIN, L. Ye.

[Abstract] On the basis of an expansion of noise-type signals [NTS] in
terms of orthogonal functions, conditions are determined which must satisfy
NTS so that their correlation functions will have the minimum possible
peaks. This establishes a basis for solution of the problem of NTS mini-
max. The following items are considered in the work: 1) Expansion of NTS
in terms of orthogonal functions; 2) Correlation functions of NTS;
3) Probability density of correlation functions of NTS; and 4) Minimization
of maximum peaks of correlation functions of NTS. It is shown that the
minimum peaks of the correlation functions also possess NTS, the coeffi-
cient of expansion of which is close to optimum. The system of orthogonal
functions in terms of which the expansion is carried out possesses a minimum
coefficient of excess. Synthesis of individual NTS, as with a system of
NTS with good correlation properties (minimum peaks), amounts to the choice
of a system of orthogonal functions with a minimum coefficient of excess.
It also leads to the construction of NTS in the form of a series in terms
of these functions with an optimum coefficient of expansion. References:
4 Russian.
[88-6415]

PECULIARITIES OF ESTIMATING NONINFORMATIVE PARAMETERS

SHCHERBAKOV, V. Yu.

[Abstract] Problems in synthesis of algorithms for point estimation of
interfering parameters are associated specifically with two peculiar
features of such an estimation, namely limited importance of the cost
function of estimation errors and indeterminacy during measurement of such
parameters. Estimation of interfering parameters is necessary for improve-
ment of the decision rule in testing two alternative hypotheses about the
informative parameter. Here minimization of the cost function and optimiza-
tion of the measuring device are considered in the pracitcal cases of error
cost function in each hypothesis independent of the interfering parameter
and its estimate, quadratic cost function in signal-absent hypothesis and
two-thirds-power cost function in signal-present hypothesis, interfering
parameter unknown, and probability density function of interfering parameter
dependent on this parameter. These examples illustrate the expediency of
including decisions of the hypothesis tester in the estimation algorithm.
It is also worthwhile to include accumulation of estimates. The peculiari-
ties of estimating an interfering parameter thus make it necessary to modify
not only the structure of the estimation functional but in some cases also
the method of measuring such a parameter. Figures 1; references 4:
3 Russian, 1 Western.
[203-2415]

OPTIMUM RECURRENT EVALUATION OF AMPLITUDE OF KEYED RADIOTELEGRAPH SIGNAL
IN CHANNEL WITH VARIABLE PARAMETERS AND FLUCTUATING NOISE

SHAROV, A. N., GROSHIKOV, Ye. N. and KOVESHNIKOV, V. G.

[Abstract] The problem is solved of a synthesis, optimum with respect to
the minimum, of the mean square error of an analyzer of the quality of a
radio channel. An algorithm is based on the calculation of a recurrent
unbiased evaluation of the amplitude of a frequency-shift keying of a signal
at the output of a communication channel which approximates a combined
Markovian process with known correlation properties. The process contains
a discrete (key sequence) component and continuous (change of the gain factor
of the channel) components. It is assumed that in the information channel,
interference operates of the fluctuating white noise type. This assumption

is permissible if as optimum working frequencies, frequencies are selected
free from high-power noise with a concentrated spectrum. Methods from the
theory of optimum linear filtration in state space are used for solution
of the problem, assuming knowledge of the correlation properties of the
signal at the output of the radio channel. The dependence is investigated
of the precision of evaluation on the interval of observation, the telegraph-
ing role and the correlation properties of the communication channel.
Figures 4; references: 10 Russian.
[88-6415]

PHASE DETERMINATION OF PSEUDORANDOM SEQUENCES IN SEGMENT WITH ASSISTANCE
OF FAST TRANSFORMS

LOSEV, V. V. and DVORNIKOV, V. D.

[Abstract] In many applications connected with synchronization, the problem
arises of determining the phase of a pseudorandom sequence with respect to
its distorted segment. The present paper considers a number of complete
optimum algorithms which implement the method of maximum probability. The
general characteristic of these algorithms is the effective organization
of the calculating process. This makes it possible substantially to reduce
the number of elementary operations required for detection of a signal.
The following items are discussed in the work: 1) Determination of phase with
absence of target indication; 2) Comparison of algorithms, and 3) Determina-
tion of phase with presence of target indication. The authors conclude that
the algorithms described take into account all, or almost all, of the
redundancy of the matrix of reference signals. They make it possible sub-
stantially to increase the efficiency of the calculation process. All the
algorithms have an identical noise immunity and completely use the correct-
ing properties of the signal. However, they differ in the speed of response,
the storage capacity of a memory or the complexity of a program, during
which these differences have an exchange nature. References: 2 Russian.
[88-6415]

MEASURES FOR IMPROVING OPERATION OF INTERCITY AUDIO BROADCAST CHANNELS

SHISHKINA, N. N.

[Abstract] This article describes the testing of the tolerances of audio-
frequency broadcast channels, including use of devices for testing amplitude-
frequency characteristics, harmonic coefficient, gain and psophometric
noise voltage during transmission pauses exceeding 1 second. The electrical
parameters of channels carried by AV-2/3 equipment have been demonstrated
to be sufficiently stable. It is pointed out that basic operating processes
must be automated in order to improve network reliability, and that auto-
mation requires the creation of a network of reserve audio broadcast
channels. References 6: 4 Russian, 2 Western in translation.
[237-6508]

DETERMINATION OF RESTORAL TIME OF NON-BLOCKING MALFUNCTIONS IN CROSSBAR
EXCHANGES

SINYAKOV, A. R.

[Abstract] There are three methods which can be used to determine restoral
time of non-blocking malfunctions, i.e ., malfunctions in which the equip-
ment continues to establish a connection, rather than becoming blocked:
expert panels, artificial malfunctions and analytical methods. Numerical
estimates of the restoral time of non-blocking malfunctions in automatic
crossbar exchanges obtained from experimental data can be used for engineer-
ing calculations of the performance and reliability indicators of automatic
crossbar exchanges. Figures 2; references 8: 7 Russian, 1 Western.
[237-6508]

PECULIARITIES OF NONLINEAR DYNAMICS OF SYSTEMS FOR QUASI-COHERENT
FILTRATION OF COMPLEX SIGNALS

TUZOV, G. I., SPIRIN, V. V. and PRYTKOV, V. I.

[Abstract] On the basis of mathematical modeling and an analysis of the
structure of two phase space equations, some results are presented of an
investigation of the dynamics of systems of quasi-coherent filtrations of
wide band pseudorandom signals. The following points are examined in the
work: 1) Combined nonfiltration system of automatic phase control [APC]
and a system of tracking after delay [TAD]; 2) Combined system of APC and
TAD with low-frequency filters; and 3) Combined system of APC and TAD of
the first orders. An analysis of the conditions of entry into a regime
of synchronism of two-circuit systems of filtration of complex signals
shows that with any values of the parameters there also exists a region of
initial conditions. Beginning with this region, establishment of a regime
of synchronism is impossible. The boundaries of this region determine the
precision of search for a signal and the corresponding extent of time ex-
penditure. This, as in the case of coherent systems, leads to the necessity
for taking a priori data into consideration. In a quasi-coherent system,
capture of a signal takes place with a larger range of changes of the input
frequency than for a coherent receiver, and it is possible to accomplish
search for a signal separately. In a search regime, it is possible to
reduce the requirements with respect to precision considerably and thereby
to reduce considerably the time of entry of the tracking system into
synchronization. Figures 8; references: 5 Russian.
[88-6415]

BASAL ALGORITHM OF DISCRETE SPACE-TIME PROCESSING ACCORDING TO MAXIMUM-
LIKELIHOOD PRINCIPLE

CHAYKOVSKIY, V. I.

[Abstract] The procedure for space-time processing of narrow-band signals
according to maximum likelihood is reduced to one analogous to that for
simultaneous detection and estimation of a useful signal by time processing
according to maximum likelihood. The basal algorithm of this processing
involves forming a hypersurface of sufficient statistics above the variation
field of the vector of estimated parameters, determining the coordinates
of its global maximum, and comparing this maximum with some threshold

according to a certain decision rule for hypothesis testing. A typical
case is a narrow-band signal with random initial phase submerged in station-
ary Gaussian interference. In the processing the transform of the excita-
tion as well as both signal and interference components of the observation
are first put in the form of matrices, which are then developed into vector-
columns, whereupon the vector representation is introduced. The computa-
tion volume can be reduced by taking into account the characteristic features
of the space-time correlation function of a scalar isotropic noise field.
It will be further reduced by absence of correlations between field receptors.
References: 4 Russian.
[203-2415]

METHODS OF FREQUENCY CONVERSION IN SUPERHETERODYNE RECEIVER

SARAYEV, S. M.

[Abstract] Several methods of frequency conversion in a superheterodyne
receiver are compared (ω_i- intermediate frequency, ω_0 receiver tuning
frequency), namely: with upper tuning of heterodyne frequency ω_h or its
m_0-th harmonic ($\omega_i = m_0\omega_h - \omega_0$), with lower tuning of heterodyne frequency
ω_h or its harmonic ($\omega_i = \omega_0 - m_0\omega_h$), and by adding ($\omega_i = \omega_0 + m_0\omega_h$) or sub-
tracting. Limits of the tuning band and the overlap factor are established
in each case on the basis of known relations with the aid of the frequency
chart. The design of a receiver requires a tradeoff between width of tuning
band and frequency separability in terms of filter power. Figures 1;
tables 2; references 3: 2 Russian, 1 Western.
[203-2415]

DETECTION BY ADAPTIVE RANK PROCEDURE

AKIMOV, P. S, and LYSYY, V. M.

[Abstract] The truncated sequential procedure for multichannel detection
with use of rank-sum nonparametric statistics and of the Neyman-Pearson
criteria for the number of observations for given correct-detection
probability and false-alarm probability (the latter independent of the

interference characteristics) is modified to an adaptive one where these two characteristics are maintained through adjustment of the full number of observations n_0 and the corresponding detection threshold C. The adaptation process involves estimation of two integrals of the interference distribution function with respect to the signal+interference mixture distribution function during the first n' observations, and then solving two equations for n_0 and C on the basis of those estimates. An adaptive multichannel device with time resolution is shown which implements this algorithm. It includes a receiver, a nominal-signal generator, a summator, two detectors, two rank calculators, a reference-sample memory, a calculator of adaptation parameters, a read-only memory, a lower-threshold calculator and a rank storage. The detection characteristics of this device with generally nonidentical channels have been analyzed by the method of statistical simulation, assuming a Rayleigh distribution of interference and a Rice distribution of signal+interference mixture. The estimates of correct-detection probability agree closely with those for a Weybull interference envelope. Figures 5; references 8: 7 Russian, 1 Western.
[203-2415]

ESTIMATING PARAMETERS OF OBJECT MOVEMENT IN INDUCTIVE COMMUNICATION SYSTEMS

IVANOV, V. S. and UL'YANITSKIY, Yu. D.

[Abstract] Inductive wireless communication inside industrial facilities is an effective means of monitoring the movement of transported objects, and is preferable to ultrashort-wave communication over relatively small floor areas (up to 20 ha). A transmitter with a loop antenna is mounted on the object. Receiver antennas are mounted under the roof above the control equipment. From a general expression for the signal induced in the receiver by the transmitter, dependent on the transmitter parameters and the carrier frequency as well as on the receiver geometry, relations are derived for estimating the instantaneous location and velocity of the object. The attainable accuracy of these estimates, determined on the basis of statistical analysis of uncorrelated time and velocity measurements according to the maximum-likelihood principle, indicates what the design parameters of the optimum receiver should be. Changes in the location of the transmitter do not affect the accuracy of measurements. Figures 2; references: 4 Russian.
[203-2415]

CRITICALITY OF SYNTHESIZED RECEIVERS OF INTERFERING RADIO PULSE SIGNALS

RYABTSOV, A. L.

[Abstract] Optimum receivers synthesized according to the theory of condi-
tional Markov processes for nonlinear filtration are critical with respect
to changes in parameters and characteristics of incoming useful and inter-
ference signals. Here algorithms of determining the criticality of such
receivers are outlined for the case of interfering radio pulses at the input,
specifically an additive mixture of useful and interference signals. The
interference signal is assumed to be a stationary normal white noise with
known statistical characteristics. The useful signal is the sum of two
sequences of video pulses of unit amplitude. The parameters to be estimated
are the delay time of such signals relative to reference pulses and the lag
time from direct signal to reflected signal arriving at the input, both
parameters assumed to be exponentially correlated stationary Gaussian pro-
cesses. Equations for the cumulants of these parameters, after averaging
over a period of the reference signal, are put in generalized form and
from their solution are obtained the respective criticality parameters.
Results of computer simulation of such a receiver reveal how the loss of
accuracy increases with increasing deviation of the input signal-to-noise
ratio from its nominal value. Figures 1; references: 4 Russian.
[203-2415]

UTILIZATION OF HYSTERESIS IN THRESHOLD RECEIVERS FOR TELEMETRY

SHAKHMARDANOV, Sh. M., IOANESYAN, V. R. and MASLENNIKOV, V. K.,
Azerbaijan Institute of Petroleum and Chemistry imeni M. Azizbekov

[Abstract] Hysteresis in the threshold device with a low-pass filter in a
telemetry receiver provides interference and false-alarm immunity. This
is demonstrated in the case of an input signal consisting of a constant-
current pulse and fluctuation noise with zero mean. A relation is established
between the necessary hysteresis voltage and input signal parameters:
residual interference level and product of ratio of filter passband to
interference frequency by ratio of signal amplitude to interference amplitude.
Residual interference is assumed to be a narrow-band random process with
both amplitude and phase slow functions of time. The leading edge of the
signal is assumed to be a ramp. A threshold receiver is designed on this

basis which consists of a comparator built with a series K140UD7 integrated analog microcircuit and a generator of threshold bias voltage. The output of the microcircuit is connected to its noninverting input through a resistive voltage divider forming the hysteresis voltage. The necessary hysteresis voltage can be found from design curves for given performance requirements such as the signal-to-noise ratio at the filter output. The paper was recommended by the Department of Information-Measurement and Computing Techniques. Figures 2; references: 3 Russian.
[202-2415]

EFFICIENCY OF RANDOM PULSE SIGNAL RECEPTION ON BACKGROUND OF WHITE NOISE

TRIFONOV, A. P. and GALUN, S. A.

[Abstract] The symptotic points (with an increase of the duration of the signal γ and the a priori interval T_o) are found of an expression for the characteristics of detection of a random signal and an evaluation of its time-dependent state in a receiver of maximum probability. The following items are considered in the work: 1) Output signal of receiver of maximum probability; 2) Detection of random pulse signal; and 3) Evaluation of time-dependent state of random pulse signal. References 12: 11 Russian, 1 Western.
[88-6415]

OPTICAL METHODS OF SIGNAL SEPARATION FROM PERIODIC BACKGROUND NOISE

ZVEREV, V. A., KOSOBURD, T. P. and MARKUS, F. A., Gor'kiy State University

[Abstract] An optical method not requiring special filters is considered for separation of signals from multiplicative periodic background noise. The equipment consists of a source of coherent light at a given wavelength in free space, andexpander forming a parallel light beam, a diaphragm, and a transparency carrying signal s(x) and noise n(x) with a field $E(x,0) = s(x)n(x)$ behind. It is demonstrated by an analysis of diffraction patterns within constraints of geometric optics that a certain distance behind the transparency, preferably within the near zone, the free space acts as a filter transforming the field so as to attenuate or even eliminate

the noise when the period of the latter does not exceed a limit determined by the system parameters. Figures 4; references: 7 Russian.
[201-2415]

SMALL COMPUTER AT CENTER OF TECHNICAL OPERATION OF TELEPHONE JUNCTION

ZELICHENOK, M. I., senior engineer, Petrograd Telephone Junction of Leningrad Urban Telephone Network, KOPYTIN, V. V., deputy chief, Leningrad Urban Telephone Network, and NESTERENKO, V. D., chief, Central Technical Operations of Vyborg Telephone Junction

[Abstract] A problem-oriented complex with an ISKRA-1256 small computer at the base has been installed in the Leningrad urban telephone network for centralized acquisition and processing of data from 15 inspection objects. Data are transmitted by the standard No. 5 international telegraph code, for which 126 binary signals and 126 inputs are available. The interrogation time is 16-90 s per object, depending on the number of emergency signals received, and the response is transmitted in 19 byte packets. The control line is supplied with ± 60 V, draws at least 25 microampere, and has a range of 12 km along TPP-0.5 cables or 25 km along TPP-0.7 cables. The computer complex includes, in addition to the ISKRA-1256 processor-interpreter, 10 auxiliary devices: keyboard, analog-to-digital converter-printer, 6 interface modules (printout, 4-kbyte memory expander, timer, two teletypes, commutator), audio-visual signalling module, data collection and transmission module. The complex operates according to a program, with two buffer zones in the computer memory for sequential interrogation of an object. A difference between consecutive data input cycles is displayed on the dispatcher's screen and recorded on magnetic tape for subsequent statistical evaluation. Output data are displayed on two formats, the first one indicating the state of all objects and the second one decoding the state of each object individually. The complex is located at the Technical Operations Center of the Petrograd telephone junction. Since its installation it has reduced the network operating costs by 52,400 rubles annually. Figures 3.
[198-2415]

DEVICE FOR CALCULATING WALSH FUNCTION SPECTRUM

[Text] A device for computing the spectrum of Walsh functions is disclosed which
contains a counter, address unit, constant assignment unit, multiplication unit,
summator, switch, comparison unit, flip-flop, cycle-number former, AND element
and control unit with first output connected to the first input of the flip-flop
the first output of which is connected to the first input of the AND element,
the output of which is connected to the first input of the control unit; the
second input of the AND element is connected to the first output of the cycle-
number former, the input of which is connected to the output of the summator;
the second output of the cycle-number former is the first output of the device
and is connected to the first inputs of the switch and comparison unit, the
output of which is connected to the second input of the flip-flop, the second
output of which is connected to the second input of the switch, the output of
which is connected to the first input of the address unit, the output of which
is connected to the input of the constant-assignment unit, the output of which
is connected to the first input of the multiplication unit, the output of which
is the second output of the device; the input of the counter is the first input
of the device, the input of the register is the second input of the device, and
the output of the register is connected to the second input of the comparison
unit. This device is distinguished by the fact that in order to increase speed
and expand functional capabilities by determining the spectrum of Walsh and
Rademacher functions using their numbers alone without generating the functions
in time, the device uses a group of AND elements, Gray code generator, shift
register, cyclic shift register and sign formation unit, the output of which
is connected to the second input of the multiplication unit; the input of the
signal formation unit is connected to the first input of the shift register and
the first output of the Gray code generator, the second and third outputs of
which are connected respectively to the first and second inputs of the summator;
the input of the Gray code generator is connected to the output of the counter;
the second input of the address unit is combined with the second input of the
control unit and connected to the outputs of the AND elements in the group,
the inputs of which are connected to the first output of the shift register,
the second output of which is connected to the third input of the address unit,
the fourth input of which is connected to the output of the cyclic shift

register, the first input of which is connected to the second input of the shift register and to the second output of the control unit; the second input of the cyclic shift register is connected to the third output of the control unit.

2. A device is disclosed, as described above, which is distinguished by the fact that the control unit contains four AND elements, a frequency divider, pulse generator, shift register and univibrator, the output of which is connected to the input of the pulse generator, the outputs of which are connected to the first inputs of three AND elements and the timing input of the shift register, the first and second outputs of which are connected to the second inputs, respectively, of the first and second AND elements, the outputs of which are, respectively, the first and third outputs of the control unit; the first and second inputs of the fourth AND elements are, respectively, the first and second inputs of the control unit, and the output of the fourth AND element is connected to the second input of the third AND element, the output of which is connected to the input of the frequency divider, the output of which is the second output of the control unit; the inputs of the shift register and univibrator are combined and serve as the control input of the device.

6900
CSO: 1860/224

VECTOR PROCESSOR

[Translation of Patent number 849228]

[Text] A vector processor is disclosed which contains a read-only memory, synch-
ronization unit, iteration counter, dual iteration flip-flop, shift signal shaper,
address formation unit, operation sign formation unit, two linear coordinate
processing units, and an angular coordinate processing unit: each linear coordinate
processing unit contains a receive register, output register, bumper register,
adder-subtractor and shift switch; the angular coordinate processing unit contains
a receive register, output register, buffer register, and adder-subtractor. The
first output of the synchronization unit is connected to the first input of the
iteration counter and the input of the dual iteration flip-flop; the second out-
put of the synchronization unit is connected to the first input of the operation
sign formation unit; the first inputs of the receive registers and buffer regis-
ters and the third output of the synchronization unit are connected to the second
input of the operation sign formation unit and to the first inputs of the output
registers; the fourth output of the synchronization unit is connected to the first
inputs of the shift signal formation unit and address formation unit; the fifth
output of the synchronization unit is connected to the third input of the opera-
tion sign formation unit, the fourth, fifth, sixth and seventh inputs of which
are connected respectively to the output of the receive register of the angular
coordinate processing unit, to the first outputs of the output register, the
angular coordinate processing unit, and the first and second linear coordinate
processing units; the first output of the dual iteration flip-flop is connected
to the second inputs of the iteration counter and the address formation unit,
the output of which is connected to the input of the read-only memory; the second
output of the dual iteration flip-flop is connected to the eighth input of the
operation sign formation unit and to the second input of the shift signal formation
unit; the output of the iteration counter is connected to the third inputs of
the address formation and of the shift signal formation unit, the output of which
is connected to the first inputs of the shift switches of the first and second
linear coordinate processing units; the output of the operational sign formation
unit is connected to the first inputs of the adder-subtractors; in each of the
linear coordinate processing sections the output of the shift switch is connected
to the second input of the adder-subtractor, the third input of which is connected

to the output of the buffer register; the output of the adder-subtractor is connected
to the second input of the output register; the second input of the shift switch
is connected to the output of the receive register; the second output of the output
register of each linear coordinate processing unit is connected to the second inputs
of the buffer register of its own and of the receive register of the other linear
coordinate processing section; in the angular coordinate processing section the
output of the adder-subtractor is connected to the second input of the output re-
gister, the second output of which is connected to the second input of the buffer
register, the output of which is connected to the third input of the adder-subtractor.
This processor is distinguished by the fact that in order to increase output and
expand the class of solvable problems, the angular coordinate processing section
uses a shift switch with its output connected to the input of the adder-subtractor
of the unit; the first and second inputs of the shift switch are connected respec-
tively to the outputs of the shift signal formation section and read-only memory;
the third inputs of the shift switches of the linear coordinate processing units
and angular coordinate processing unit are connected respectively to the output
of the buffer registers of these units, while the output of the receive register
of the angular coordinate processing unit is connected to the fourth input of
the shift switch and the third input of the buffer register serving that unit.

6900
CSO: 1860/224

RANDOM PULSE SEQUENCE GENERATOR

[Translation of Patent number 847498]

[Text] A random pulse sequence generator is disclosed which contains a code sequence generator, decoder and switching section. This generator is distinguished by the fact that in order to expand functional capabilities by regulating the principle by which the time interval between pulses is varied it uses a delay unit and, in series, a pulse shaper, interrupt unit and time interval formation unit, the output of which is connected to the first input of the switching unit, the second input of which is connected through the delay unit to the output of the pulse shaper, the input of which is connected to the output of the switching unit; the third input of the switching unit is connected through the decoder to the output of the pulsed sequence generator.

6900
CSO: 1860/224

RANDOM NUMBER GENERATOR

[Translation of Patent number 888117]

[Text] A random number generator is disclosed which contains a primary random
signal source with output connected to the first input of a first AND element
and to the first input of a comparison section, the second input of which is
connected to the output of a memory section and the output of the comparison
section connected to the second input of the first AND element and to the inverse
input of the second AND element, and a dynamic memory section. This generator is
distinguished by the fact that for simplification it contains an OR element
with output serving as the output of the generator and being connected to the
input of the dynamic memory section, the output of which is connected to the
direct input of the second AND element, the output of which is connected to the
first input of the OR element, the second input of which is connected to the out-
put of the first AND element.

6900
CSO: 1860/220

DEVICE FOR DETECTING MOMENT AT WHICH PROPERTIES OF RANDOM PROCESS CHANGE

[Translation of Patent number 888133]

[Text]   1.   A device is disclosed for detecting the moment at which the properties
of a random process change which consists of a control unit, the first output of
which is connected to the first input of an analog-digital converter, the second
input of which is the input of the device, a multiplication section, summator
and two shift registers. This device is distinguished by the fact that in order
to expand its functional capabilities by determining the moment at which the
mathematical expectancy and correlation function change, it uses five registers,
three shift registers, three OR elements, two AND elements, a delay element and
start button. The first input of the first register is combined with the first
input of the second register and connected to the first input of the control unit;
the output of the first shift register is connected to the first input of the
first shift register and to the first input of the first OR element, the second
output of which is combined with the first inputs of the second shift register
and connected to the output of the second shift register; the first input and
output of the third shift register are combined and connected to the first input
of the second OR element, the output of which is connected to the input of the
summator, whose first input is connected to the first input of the fourth shift
register, the fourth output of which is connected to the first input of the
third OR element, the second of which is combined with the second input of the
first OR element and connected to the second output of the fourth shift register;
the output of the second register is connected to the third input of the third OR
element, the output of which is connected to the first input of the multiplication
section, the second of which is connected to the output of the first OR element;
the first output of the multiplication section is connected to the second input
of the second OR element, the third element of which is connected to the output
of the fifth shift register, the first input of which is connected to the second
output of the summator, the third output of which is connected to the first
inputs of the first and second AND elements, the output of which is connected to
the first input of the control section; the outputs of the third, fourth and
fifth registers are connected respectively to the fourth, fifth and sixth inputs
of the second OR element, the seventh input of which is connected to the output
of the first register; the second input is combined with the second inputs of

92

the fourth and fifth shift registers and connected to the second output of the control unit; the third input of the first register, fourth and fifth shift registers are combined and connected to the third output of the control unit, the fourth output of which is connected to the second inputs of the second register and first shift register, the fourth input of the fifth register and the second input of the third shift register, the third input of which is combined with the third inputs of the second register and first shift register and with the fifth input of the fifth shift register and connected to the fifth output of the control unit, the sixth output of which is connected to the fourth input of the fourth shift register; the seventh output of the control unit is connected to the fifth input of the fourth shift register, the sixth input of which is combined with the third input of the third shift register and connected to the eighth output of the control unit, the ninth output of which is connected to the third input of the second shift register and the seventh input of the fourth shift register, the eighth input of which is connected to the second output of the multiplication section; the input of the third register is connected to the tenth output of the control unit, the eleventh output of which is connected to the first input of the fifth register, the second input of which is connected to the output of the first AND element, the second input of which is connected to the twelfth output of the control unit; the thirteenth output of the control unit is connected to the second input of the second AND element, to the third input of the fifth register and to the input of the fourth register; the fourth inputs of the first and second register are combined and connected to the output of the analog-digital converter; the output of the start button is connected to the second input of the control unit and through a delay element to the fifth input of the first register.

2. A device is disclosed as described above which is distinguished by the fact that the control unit contains a pulse generator, AND element, flip-flop and twelve delay elements in series; the output of the pulse generator is connected to the first input of the AND element, the second input of which is connected to the output of the flip-flop, the ones input of which is the second input of the unit; the zero input of the flip-flop is the first input of the unit; the output of the AND element is the first output of the control unit, and the outputs of the delay elements are connected respectively to the outputs of the second through the thirteenth control units.

RANDOM PROCESS GENERATOR

[Translation of Patent number 849464]

[Text] A random process generator is disclosed, as described in Patent number
439064, which is distinguished by the fact that in order to expand functional
capabilities by automating the regulation of the statistical characteristics of
the process being monitored it uses additionally, in series, a sync pulse gener-
ator, synchronizer, control pulse generator, pulse shaper, memory, register and
decoder; the output of the control pulse generator is connected to the control
input of the memory and to the input in the zero state of the register; the
second output of the synchronizer is connected to the input of the master pulse
generator, while the outputs of the additional decoder are connected to the
corresponding inputs of the switch.

6900
CSO: 1860/224

PSEUDORANDOM NUMBER GENERATOR

[Translation of Patent number 890391]

[Text] A pseudorandom number generator is disclosed which contains an m-bit
shift register, first OR element with inverse output of mth shift register bit
connected to its first input, a second AND element with direct output of mth bit
of shift register connected to its first input, and an OR element with its output
connected to the input of the first bit of the shift register. This generator is
distinguished by the fact that in order to increase accuracy it contains a third
AND element, fourth AND element and an NOR element. The inverse and direct outputs
of the jth bit of the shift register are connected respectively to the second
inputs of the first and second AND elements; the outputs of the first and second
AND elements are connected to the first and second inputs of the NOR element; the
inverse outputs of the $m - 1$ first bits of the shift register are connected to
the inputs of the fourth AND element; the output of the fourth AND element is
connected to the third input of the NOR element and the first input of the third
AND element, to the second input of which is connected the inverse input of the
mth bit of the shift register; the output of the NOR element is connected to the
first input of the OR element, to the second input of which is connected the
output of the third AND element.

6900
CSO: 1860/220

FERRITE VALVE-FLANGE FOR 4-MM WAVE BAND

BOCHKAREV, A. I. and KURUSHIN, Ye. P.

[Abstract] The feasibility of producing valves for the 4-mm wave band
analogous to those for the 7-8 mm wave band within the $l\omega^p$ = const constraint
(1- length, ω- radian frequency, p- small number) has been established on
the basis of numerical simulation of an H-plane two-dimensional valve-
flange model. The electrodynamic characteristics of such a device using
commercial ferrite materials were calculated, specifically forward and back-
ward power losses and reflection coefficient at valve input over the
64-70 GHz frequency range for coupling 3.6×1.8 mm^2 waveguides. The results
reveal the dependence of these characteristics on the position of the
ferrite-dielectric resonator inside the coupler. These results serve as
basis of experimental dvelopment of such valves. Figures 3; references:
9 Russian.
[203-2415]

RATIONAL DESIGN OF ELECTRODES IN SYMMETRIC STRIPLINES FOR FORMATION OF HEAVY NANOSECOND PULSES

NOVGORODTSEV, A. B., candidate of technical sciences, docent, Order of
Lenin Polytechnic Institute imeni M. I. Kalinin, Leningrad, and
FAKHTIYEV, A. R., candidate of technical sciences, Institute of Aviation
imeni S. Ordzhonikidze, Ufa

[Abstract] Stripline storage devices, or coaxial lines, are used with
generators of heavy nanosecond pulses for controlling the power and the
duration of these pulses. Their performance depends largely on limitation
of the maximum electric field intensity at the edges of the electrodes,
which usually have rounded corners. Here a procedure for designing the
center electrode in a symmetric stripline is shown which will ensure a
uniform maximum electric field intensity along a rounded corner. Calcu-
lations are made by the method of conformal mapping, with the center
electrode of finite width assumed to be under a voltage and the outer two
electrodes at zero (ground) potential assumed to be infinitely wide.
Relations are established between the pertinent relative dimensions of
the center electrode, the spacing of the electrodes on the stripline, and
the ratio of electric field intensity at the corner to voltage gradient
across the stripline. These relations are presented graphically in the
form of curves, for design calculations. Figures 3; references 3:
2 Russian, 1 Western.
[242-2415]

ANALYSIS OF NOISE PARAMETERS AND DESIGN OF LOW-NOISE WIDEBAND AMPLIFIERS

IGNATOV, B. N., KONDRATENKO, S. V. and KOROLEV, V. A.

[Abstract] The feasibility of numerically tabulating not only the signal
characteristics but also the noise characteristics of transistors, on the
basis of the equivalent circuit diagram, is established for the typical
case of a bipolar device. Such tables are useful for computer-aided de-
sign of low-noise wideband amplifiers. Figures 4; tables 1;
references 4: 2 Russian, 2 Western.
[203-2415]

ANALYSIS AND CALCULATION OF FREQUENCY INSTABILITY IN CONTROLLED QUARTZ
OSCILLATOR

MASLOV, V. A.

[Abstract] Frequency instability in a controlled quartz oscillator is
analyzed for the case of an input reactance of the generator circuit much
lower than the reactances in the frequency control circuit. Calculations
yield the same instability coefficient regardless of the branch of the tank
circuit into which the active device has been inserted. The relation between
frequency and control voltage depends intricately on the frequency deviation
range and can become unstable, at different rates, because of instability
of various circuit components. The stability of this relation can be im-
proved by design. A family of curves is available as convenient aid for
calculations. Figures 2; references 8: 5 Russian, 3 Western.
[203-2415]

TUNED AMPLIFIERS USING MOS POWER TRANSISTORS AND THEIR DESIGN WITH AID OF
DIGITAL COMPUTER

D'YAKONOV, V. P. and SEMENOVA, O. V.

[Abstract] A procedure for designing tuned amplifiers with MOS power
transistors (KP901 and KP904 for frequencies up to 100 MHz with power
rating up to 10 and 50 W, respective, KP907 with power rating up to 12 W
at 0.5 GHz and up to 6 W at 1 GHz) is outlined, including the use of
schematic and equivalent circuit diagrams and linear-exponential approxima-
tion of the current-voltage output characteristic. The complete system
of nonlinear differential equations of state for the output stage is solved
by the implicit Euler method on a digital computer, which also calculates
transient and steady-state performance characteristics. Typical parameters,
curves and oscillograms for a class B amplifier are shown. Figures 4;
references: 5 Russian.
[203-2415]

INFLUENCE OF DESIGN FACTORS ON WRITE CURRENTS IN PROM'S WITH FUSIBLE LINKS

CHISTYAKOV, Yu. D., MIKADZE, V. V. and MOSHKIN, V. I., Institute of
Electronic Engineering, Moscow

[Abstract] An analysis is made of the influence of design factors on write
currents in PROM's (programmable read-only memories) which are programmed
by breaking fusible links, and are heated by electric current and volatilized.
High write current densities on the order of $2.5 \cdot 10^7$ A/cm^2 are required for
breaking fusible links in presentday PROM integrated circuits, and this makes
a further increase in level of integration to greater than 64 to 128 K bits
on a chip practically impossible, because of the increased probability of
failure with a reduction in size of circuit elements. The only viable
alternative is to reduce write currents by the control of design factors.
Reducing the dimensions of fusible links too drastically reduces the
reliability of the PROM, on account of electromigration, in particular.
The value of the critical write current and time required for reaching the
critical temperature for fusing or softening the link's material are
determined by solving an equation describing the heat balance in a model of
a PROM element. The critical write current density required for breaking
a link is determined from the condition for reaching the critical temperature.
It is demonstrated that the required write current density, j_0, can be re-
duced by making fusible links out of materials with low values of parameter
$(T_{kr} - T_0)/\rho$, where T_{kr} is the critical temperature mentioned above and T_0
is the initial temperature and ρ is the resistivity. In order to reduce
the critical current, I_{kr}, it is feasible to reduce the width of a link. Two
methods of lowering $T_{kr} - T_0$ are investigated: uniform heating of the PROM
chip, and achieving a local increase in the temperature of the fusible link
to be broken on account of an external source, e.g., a laser beam, or a
source built into the structure of the PROM. It is possible to use heat
released in active or passive elements of the PROM to achieve a local in-
crease in T_{kr} without increasing the current through it. The heat released
in the write mode in decoupling diodes can be used in PROM's based on diode
arrays. The fusible link is then positioned near the heat release zone.

Decoupling diodes are back-biased since lower current is thereby required for heating their p-n junctions than with forward biasing. By placing fusible links above the heat releasing elements of the PROM it is possible to lower write currents by more than an order of magnitude, or 10- to 50-fold, and to create the conditions required for increasing the level of integration. Figures 3; references 8: 6 Russian, 2 Western (1 in translation).
[210-8831]

SYNTHESIS OF AMPLITUDINAL SPACE-FREQUENCY FILTERS FOR COHERENT OPTICAL PROCESSOR

OCHIN, Ye. F., Leningrad Institute of Precision Mechanics and Optics

[Abstract] Two pairs of non-negative amplitudinal space-frequency filters are synthesized by application of optical holography, one for a differentiating filter $\frac{\partial}{\partial x} \alpha(x,y)$ with transfer function $H(\xi,\eta) = c\xi$ ($c = 2\pi/\lambda f$, λ- wavelength of light, f- focal length of lens) and one for a differentiating filter $\frac{\partial}{\partial x \partial y} \alpha(x,y)$ with transfer function $H(\xi,\eta) = c\xi$ ($c \to -4\pi^2/\lambda f$). More universal methods, for filters with arbitrary transfer functions, are those of digital holography such as binary coding with phase modulation at only two levels 0 and 1. A comparative analysis of width coding, height coding and width-height coding in a typical 6x6 Loman cell for accuracy indicates that the error is, respectively, 12.5, 4.2 and 3.15%, the error of optimal coding being 2.1%. The technology of filter synthesis by digital holography involves first magnification of a synthesized hologram taken from the computer and then photographic reduction of the hologram, the latter process introducing uncontrollable errors. At least one method of synthesis is already available, based on electron-beam lithography, which does not require reduction. The paper was recommended by the Department (Kafedra) of Computing Techniques. Figures 5; references 4: 1 Russian, 3 Western.
[202-2415]

CONTRAST DISSIPATIVE STRUCTURES AND DOMAIN WALLS IN ACTIVE DIFFUSION MEDIUM

BALKAREY, Yu. I., YEVTIKHOV, M. G. and YELINSON, M. I., Institute of Radio
Engineering and Electronics, USSR Academy of Sciences

[Abstract] Three-dimensional stratification originates under certain condi-
tions in active kinetic systems of the diffusion type and in strongly non-
equilibrium systems this type of stratification has been called a three-
dimensional dissipative structure. Dissipative structures can be used to
create active memory systems which not only record but also partly process
three-dimensional information, such as isolation of the outlines and corners
and the regeneration of certain lost elements of a picture. Three-dimensional
dissipative structures are divided into quasi-harmonic and contrast. Pre-
vious studies by the authors (1979, 1980) were devoted to discussion of the
processes of the formation in time of various periodic and non-periodic uni-
dimensional and two-dimensional contrast structures, by means of a numerical
experiment, on the basis of a specific mathematical model of an active
medium with diffusion. The discussion was limited to cases when a three-
dimensional homogeneous system, i.e., a point model, had self-oscillating
or potentially self-oscillating properties, corresponding to the delay mode,
when the system, after the final impulse, issues a drive pulse and returns
to the original state. In the present paper a system is discussed in which
the point model has trigger properties. The medium is described by two
equations which under certain conditions provide a qualitative description
of the Belousov-Zhabotinskiy chemical "autowave" medium. The model used
is typical of the class of active diffusion systems but is expanded and
some parameters are changed to produce the trigger mode. In the trigger
mode the structures are in the form of wide domains bounded by narrow
domain walls separating stable stationary states. The formation of domain
walls and the transformation of a stationary structure into a set of moving
domain walls when the system is switched from the delay to the trigger mode
are discussed. An illustration is given of the process of the formation of
a domain wall from a stepped initial perturbation. An illustration is given
of the tranformation of a stationary system of narrow and wide strata formed
in the delay mode after switching to the trigger mode. Narrow strata slowly
broaden on account of movement of the walls and walls disappear when they
meet one another and boundaries. In the trigger mode, as distinct from the
delay mode, a three-dimensionally inhomogeneous perturbation applied to the
medium does not change its form up to the conversion of boundaries into do-
main walls if the velocity of the walls is low, or the region of the initial
perturbation expands on account of movement of the walls. Boundaries which
are fuzzy at the starting moment are converted into walls and become sharp.
It is therefore possible to use the medium in this mode as a memory which,
with a slow rate of movement of the domain walls, preserves the form of the
initial perturbation, just correcting its boundaries. The trigger mode
discussed adds to the possibilities of using an "autowave" medium as an
active memory. Figures 6; references 13: 11 Russian, 2 Western.
[210-8831]

QUANTITATIVE CHARACTERISTICS OF IMPROVING RELIABILITY OF SEMICONDUCTOR
MEMORIES BY ERROR DETECTION AND CORRECTION

BORISOV, V. S.

[Abstract] The reliability of large-capacity semiconductor memories built
on the basis of large-scale integration is now more widely improved by
structural-circuital engineering methods using error detection and correc-
tion algorithms with the necessary degree of hardware redundancy. As a
quantitative criterion of reliability improvement can serve an indicator
of longer mean time between failures. The probability of an error occurring
twice in the storage device is expressed through the probability of an
error occurring once in the nonredundant version of this device, the ratio
of both probabilities becoming the reliability improvement factor. Here
analytical expressions are derived for both probabilities and the reliability
improvement factor is calculated for a typical LSI memory with linear code
modules and error correction. The results reveal that the reliability im-
provement factor decreases with increasing word length, with longer operat-
ing time, and with an increasing failure rate. The design of error detection
and correction systems for memories depends on the scale of integration,
among others, busbar-processor and processor-memory interfaces of the
coupling kind being appropriate in large-scale integration. Figures 2;
references 11: 10 Russian, 1 Western.
[250-2415]

CHARACTERISTICS OF ELECTRICALLY REPROGRAMMABLE MOS COMPONENTS IN MEMORY
WITH FLOATING ELECTRODES

BELYAYEV, S. N., KOLYASNIKOV, V. A., RAKITIN, V. V., STARIKOVA, T. I.,
TISHIN, Yu. I. and ENKOVICH, V. A.

[Abstract] Structures $Si-SiO_2-Si$(polycrystalline)$-SiO_2-$metal, where poly-
crystalline silicon serves as floating electrode, are used in electrically
reprogrammable read-only memories. This is feasible because of the higher
electrical conductivity of SiO_2 thermally grown on polycrystalline silicon
and the possibility of varying the charge on the floating electrode upon
application of a voltage pulse to metal electrode. Here are examined the
polarization characteristics of such structures, the current-voltage charac-
teristic of SiO_2 on polycrystalline silicon, and degradation as a result

of switching. The theoretical analysis is based on the Fauler-Nordheim relation describing the electron tunneling mechanism in the recording mode and on the Schottky relation describing the mechanism of electron emission through a barrier lowered by an external field in the charge storage mode. The theoretical results agree qualitatively with experimental data obtained with a polycrystalline silicon layer doped with phosphorus to concentration $n \geq 10^{19}$ cm^{-3}, on a p-Si substrate and under an aluminum upper electrode. Figures 6; references 5: 2 Russian, 3 Western.
[250-2415]

ANALYSIS OF DYNAMIC PROPERTIES OF TIME-PULSE QUADRATIC DEMODULATORS

GERASIMOV, I. V. and KOSTICHEV, S. V., Leningrad Electrical Engineering Institute imeni V. I. Ul'yanov (Lenin)

[Abstract] The paper discusses a method for obtaining one of the mathematical models of time-pulse quadratic demodulators, taking into account the special features of devices with neutralization of width-modulated pulse sequences. A functional diagram of the quadratic demodulator is presented. It is necessary to consider the demodulator as an open pulse system representing an electrical network with periodic commutation parameters. The paper was recommended by the Department (Kafedra) of Computing Techniques. Figures 2; references: 6 Russian.
[151-6415]

CONTROL SYSTEMS

SAFONOV, V. M.

[Abstract] A phase-tracking automatic frequency control system with a
sawtooth characteristic of the phase detector, corresponding to a third-
order nonlinear differential equation, is analyzed in the region of the
space of equation parameters where the relative frequency deviation at the
boundary of the locking band equals the relative frequency deviation on the
separatrix loop. Three filters are considered: a 0/2 filter, a pair of
identical proportionally integrating 1/1 filters in series, and a rejection
filter. Calculations confirm the possibility of two collocations at the
right-hand boundary of the separatrix plane, reveal the noise bands in
each case, and yield the transmission coefficient at the frequency of external
harmonic phase oscillations. The results indicate that, for equal locking
bands, the noise band is wider but the filtration of external harmonic
phase oscillations is better with a two-section than with a one-section
1/1 filter. Figures 1; tables 1; references: 7 Russian.
[203-2415]

INTERCALATION COMPOUNDS OF SEMICONDUCTORS AND DIELECTRICS

KOSHKIN, V. M., All-Union Scientific-Research Institute of Monocrystals,
Khar'kov

[Abstract] A brief survey is presented of investigation on intercalated
dielectrics and semiconductors, an analysis is conducted of those common
regularities of intercalcated phenomena which appear to be the most important
in an application of nonmetallic matrices, and finally an attempt is made
to designate certain most interesting aspects of a study of intercalated
dielectrics and semiconductors. The following items are considered:
1) Interaction of "Host-Guest" in intercalated crystals; 2) Interaction of
"Molecule-Guest", crystal structure and stoichiometry of intercalation
compounds; and 3) Some problems of physics and electronics of intercalated
semiconductors. Figures 2; references 36: 23 Russian, 13 Western.
[177-6415]

ELEMENTARY PROCESSES OF CHARGE CARRIER FORMATION IN ORGANIC DIELECTRICS
WITH RADIATION EFFECT

YAKOVLEV, B. S., Institute of Chemical Physics, USSR Academy of Sciences

[Abstract] This paper is part of the material of the 11th All-Union
Coordination Conference On Organic Semiconductors. A survey is presented
of investigations made of charge carrier formation processes in organic
insulators such as liquid and solid saturated hydrocarbons. The following

items are considered: 1) Two stages of formation of charge carriers;
2) Separation and initial recombinations of electron-ion paris; 3) Thermali-
zation and drift mobility of electrons; 4) Thermalization and drift mobility
of electrons in liquid hydrocarbons; and 5) Generation of charge carriers
stimulated by photo-excitation of electron-ion pairs. It is shown that
various experimental data confirm the concept of formation of thermalized
electron pairs by the action of ionizing radiation on organic insulators
as an intermediate stage of charge carrier generation. In a description
of the processes following after this stage, a satisfactory quantitative
agreement with experiment for nonpolar amorphous insulators provides a
diffusion (Onsager) model. The least investigated are the processes pre-
ceding the formation of thermalized pairs of charged particles--decay of
autoionized states and thermalization of charge particles in the Coulomb
fields of one another. In the creation of the experimental basis for the
development of the theory for these processes, significant direct experi-
mental measurements started recently of the lengths of thermalization and
localization of low-energy electrons and their dependence in molecular
condense media are presented. Figures 4; tables 1; references 23:
10 Russian, 13 Western.
[177-6415]

EFFECTIVE DIELECTRIC PARAMETERS OF SNOW CAP BASED ON RADIOMETRIC MEASUREMENTS

GERSHENZON, V. Ye., KHAPIN, Yu. B. and ETKIN, V. S., Institute of Space
Research, USBR Academy of Sciences

[Abstract] A model experiment was performed for the purpose of determining
the effective dielectric parameters, namely permittivity and loss tangent,
of a snow cap. The brightness temperature at three radio frequencies (20,
37, 89 GHz) was measured, assuming a uniform thermodynamic temperature
throughout the cap, first with a specimen of a natural triple-layer soil-
snow-air structure on an almost ideally black etalon and then with a speci-
men of snow crust alone on an almost ideally reflecting aluminum sheet.
The results of measurements reveal strong scattering of millimeter waves by
snow and ice crystals. The intensity of scattering decreases as the snow
cap melts and its thickness thus decreases. As the wavelength is increased,
the scattering action of snow becomes weaker and the action of the ground
surface becomes stronger. On the basis of established relations for the cap
thickness and the emissivity of snow, in terms of the loss tangent and the
real part of complex dielectric permittivity, it is thus possible to detect
and explore snow caps by the radiometric method. The authors thank
V. V. Meriakri for discussing some of the results. Figures 2; tables 2;
references 5: 3 Russian, 2 Western.
[201-2415]

ELECTRON DEVICES

OPTICAL RANDOM-SIGNAL SPECTRUM ANALYZER

[Translation of Patent number 890262]

[Text] An optical spectrum analyzer for random signals is disclosed which contains
optically coupled and sequentially arranged coherent light source, collimator,
space-time modulator, first integrating lens and opaque screen, arranged in one
of two spatial frequency planes, and optically connected transparency, second
integrating lens and first photoreceptor located in the other spatial frequency
plane, and optically coupled third integrating lens and second photoreceptor,
plus a division section, square-root extraction section and multiplication section.
This analyzer is distinguished by the fact that in order to improve the statistical
properties of the average value obtained for the fluctuations of the average fre-
quency of the spectrum of the signal being investigated it uses an averaging
section; the outputs of the first and second photoreceptors are connected respec-
tively to the first and second inputs of the division section, the output of
which is connected through series-connected square-root extraction section and
multiplication section to the input of the averaging section.

6900
CSO: 1860/220

ORGANIC SEMICONDUCTORS AS MODEL SYSTEMS FOR PRIMARY PHOTOPROCESSES IN
PHOTOBIOLOGY

FRANKEVICH, Ye. L. and TRIBEL', M. M., Institute of Chemical Physics,
USSR Academy of Sciences

[Abstract] The paper considers the possibility of investigation of un-
balanced spin processes in biological and model systems going through an
intermediate state, which consists of pairs of paramagnetic particles.
Such, for example, as ion radicals. The necessity for inclusion of model
systems, among which not the last place is occupied by molecular crystals
and organic semiconductors, is caused by complex processes which preceed
even in the simplest biological objects. Any photobiological process is
a succession of various stages, differing in their nature and requiring a
change of the investigation procedures. Certain primary physical and
chemical processes are considered in the paper which are directly connected
with absorption of light. In spite of the large variety of photobiologi-
cal reactions all of them are more or less characterized by a common
series of stages. The following items are discussed: 1) Primary photo-
processes; 2) Magnetic spin effects; 3) Spin effects in solid layers of
chlorophyll; 4) Spin effect in chlorophyll solutions; 5) Spin effects in
reaction centers of photosynthesizing organisms; and 6) Spin effects during
photosynthesis in vivo. It is shown that evolution of spin pairs depends on
the interior and exterior fields, and appears in magnetic effects on photo-
conductivity or fluorescence of both model or real photosynthesizing systems.
Figures 7; references 13: 7 Russian, 6 Western.
[177-6415]

SCHOTTKY BARRIERS AND THEIR USE FOR STUDYING PROPERTIES OF SEMICONDUCTORS

GOL'DBERG, Yu. A., Physicotechnical Institute imeni A. F. Ioffe,
USSR Academy of Sciences, Leningrad

[Abstract] The basis of a Schottky diode is a metal-semiconductor structure
with a potential barrier at the semiconductor surface (an m-s structure).
The key advantage of m-s structures, as opposed to p-n structures, is that in
their creation the properties of the original semiconductor do not change,
chiefly because m-s structures are created at fairly low temperatures. This
makes it possible to use these structures to study the properties of semi-
conductor materials. Schottky barriers are being used to study: 1) The
energy distribution of charge carriers in a semiconductor, including the
width of the forbidden band, the minimum energy of cross-over transitions
and the energy distribution of surface states, 2) The behavior of impurities
in a semiconductor, including the concentration of impurities, their ioniza-
tion energy, the trapping cross section for an electron, hole or photon
by an impurity center, and the center's pohotionization cross section, and
3) The absorption of light and recombination of charge carriers in a semi-
conductor, including the light absorption coefficient and the diffusion and
drift length of minority carriers. Schottky barriers are being used to
study new materials, including compounds, solid solutions and variable-
band semiconductors with energy bands which vary along the coordinates of
their structure. The space charge layer present near the surface of the
semiconductor in Schottky barriers can easily be varied in terms of its
width and the strength of the electric field in it by means of biased voltage.
It is thus possible to alter the charge and degree of ionization of impurity
atoms and the width of the region for the gathering of nonequilibrium
carriers which originate in the photoelectric effect. Many of the methods
employed to measure the parameters of semiconductor materials are more
accurate and simpler than traditional methods. The ability to employ
direct nondestructive methods of measurement is a great advantage. For
example, determination of the parameters of a band diagram by the Schottky
barrier method is based on the fact that the photocurrent spectrum with
small absorption coefficients is similar to the absorption spectrum. This
method does not require making thin specimens, as in the traditional method
based on measuring the transmittance of a semiconductor, but makes it pos-
sible to determine the width of the forbidden band directly in the semi-
conductor device and results in higher measurement accuracy because current
can be measured more precisely than the intensity of light. The paper is
based on the material of a lecture read by the author at the Second School
On Microelectronics at Primorsko (Bulgaria) in June 1979. Figures 8;
references 70: 27 Russian, 43 Western.
[210-8831]

PHOTOMEMORY ON METAL-SEMICONDUCTOR JUNCTION USING GeSe SINGLE CRYSTALS

KYAZYM-ZADE, A. G., PANAKHOV, M. M. and TAGIROV, V. I., Azerbaijan State
University imeni S. M. Kirov, Baku

[Abstract] Luminous nonequilibrium straightening of energy bands and re-
covery of the potential barrier at room temperature was studied in high-
resistivity Schottky-barrier GeSe single crystals with low concentration
of surface electron states. A semitranslucent aluminum layer deposited
on the fresh surface of 2x2-4x4 mm^2 large and 50-200 micrometer thick
p-GeSe single crystals formed the straightening barrier. A flash from an
ISSh-100 3M lamp of 3 microsecond duration and 10^{18} quanta/$cm^2 \cdot$s maximum
intensity served as excitation. The height of the barrier was found to
decrease exponentially during illumination, with the time constant inversely
proportional to the light intensity, and to recover slowly nonexponentially
after illumination. A forward bias applied at the end of the light pulse
causes relaxation of the barrier to a quasi-equilibrium height. It will also
erase the photomemory when applied at a later time. Figures 3; tables 1;
references 18: 17 Russian, 1 Western.
[249-2415]

LUMINESCENCE OF NITROGENOUS IMPURITY-DEFECT COMPLEXES IN ION-IMPLANTATION
LAYERS OF NATURAL DIAMOND

ZAYTSEV, A. M., GIPPIUS, A. A. and VAVILOV, V. S., Institute of Physics
imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] An experimental study was made, by the cathodoluminescence
method, of diamond layers containing implanted nitrogen. Into lamina of
natural diamond (grades IIa and Ia with fewer than 10^{18} cm^{-3}, respectively
and at least 10^{19} cm^{-3} nitrogen atoms) were implanted at room temperature,
in a High-Voltage Engineering Europa accelerator, nitrogen ions with energy
up to 350 keV in doses designed to produce the appropriate impurity concen-
tration profile. The specimens were then annealed in a graphite crucible
for 2 h under a 10^{-5} torr vacuum at temperatures from 500 to 1400°C.
Cathodoluminescence was excited with a 2-10 keV electron beam at a current
of 5 microampere and was analyzed at 80 K in the 300-900 micrometer range of
the wavelength spectrum. Luminescence centers and corresponding lines

appeared as follows: 389 and 441.5 nm immediately after implantation, 575 nm after annealing at T > 500°C, 415 and 503 nm after annealing at T > 1000°C, while 389 and 441.5 nm vanished, 439 and 539 nm after annealing at T ~ 1400°C. The data on the dependence of the line intensities on the implantation dose and the annealing temperature yield new information about the microstructure of nitrogen-complex centers and their "softness" as well as their transformation. The authors thank A. V. Spitsyn and V. A. Dravin for performing the ion implantation, N. A. Shuvalova for annealing the specimens, and Ye. V. Sobolev and Ye. A. Konorova for disucssing the results. Figures 5; references 26: 11 Russian, 15 Western.
[249-2415]

FORMATION, ANNEALING AND INTERACTION OF DEFECTS IN ION-IMPLANTATION LAYERS OF NATURAL DIAMOND

GIPPIUS, A. A., ZAYTSEV, A. M. and VAVILOV, V. S., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] An experimental study was made by the cathodoluminescence method of defects in ion-implantation layers of diamond. Into crystals of natural diamond (grades IIa and Ia with, respectively, fewer than 10^{18} cm^{-3} and at least 10^{19} cm^{-3} nitrogen atoms) 30-350 keV ions in 10^{11}-10^{15} cm^{-2} doses in a High Voltage Engineering Europa heavy-ion accelerator. The specimens were then annealed in a graphite crucible for 2 h under a 10^{-5} torr vacuum at 150-1400°C. Some specimens were bombarded with 2.2 MeV or 10 keV electrons for subthreshold defect formation. Cathodoluminescence was excited with a 2-20 keV electron beam at a current of 5 microampere and analyzed at 80 K in the 300-900 nm range of the wavelength spectrum. In the unannealed state after implantation, defects were found not to depend on the one controlling impurity (nitrogen) but the spectral lines were found to depend on the kind of implanted ions (H^{+}, C^{+}, N^{+}). The data on quenching and intensification of luminescence lines, on interaction of defects and their annealing as well as on the effect of surrounding defects on the annealing of luminescence centers, especially in layers with large implantation dose, reveal a definite role of nitrogen and confirm the concept of disordered domains. The authors thank A. V. Spitsyn and V. A. Dravin for performing the ion implantation, N. A. Shuvalova for annealing the specimens, Ye. A. Konorova and V. V. Krasnopevtsev for their valuable comments and discussion of the results. Figures 8; references 22: 8 Russian, 14 Western.
[249-2415]

MANIFESTATION OF RESIDUAL IMPURITIES IN PURE GERMANIUM DURING GAMMA-
IRRADIATION

YEMTSEV, V. V., MASHOVETS, T. V. and NAZARYAN, Ye. Kh., Physical Technical
Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] Fast-diffusing impurities in germanium crystals can, upon heat
treatment or irradiation, change from the inactive state to the electrically
active state and thus affect the reliability of germanium detectors.
"Activation" of copper impurity by irradiation from a Co^{60} source was ex-
perimentally studied in pure and extra-pure germanium single crystals with
concentrations of charge carriers 10^{12}-10^{13} cm^{-3} and at most 10^{11} cm^{-3},
respectively. Electrical measurements at 4.2-300 K before irradiation re-
vealed a predominance of aluminum (rarely gallium) in p-type crystals and
of phosphorous (rarely arsenic) in n-type crystals. The concentration of
E_v + 0.043 eV impurity centers caused by substituting copper atoms could be
determined after irradiation: in p-type crystals directly from the tempera-
ture dependence of the hole concentration over the 20-100 K range, in p-type
crystals only indirectly from the total concentration of compensating
acceptors with acceptor and donor concentrations determined separately.
After complete activation the concentration of active copper atoms was not
higher than $5 \cdot 10^{11}$ cm^{-3} (pure) and 10^{11} cm^{-3} (extra-pure) in p-type crystals
and as much as $(2-4) \cdot 10^{12}$ cm^{-3} in the acceptor state in n-type crystals.
The authors thank E. E. Haller for supplying the extra-pure specimens from
the Lawrence Laboratory at the University of California. Figures 1;
tables 2; references 11: 5 Russian, 6 Western (one in translation).
[249-2415]

CHAIN PROCESS OF DEFECT ANNIHILATION IN SEMICONDUCTOR CRYSTALS

CHERDANTSEV, P. A., CHERNOV, I. P. and MAMONTOV, A. P., Scientific
Research Institute of Nuclear Physics, Tomsk Polytechnic Institute
imeni S. M. Kirov

[Abstract] Acceleration of the defect annihilation process in silicon and
GaAs crystals is analyzed on the basis of the energy dissipation model. The
mean probability of excitation of electron-hole states during annihilation
of a Frenkel pair is described by the Landau-Einer equation and an annihila-
tion domain is regarded as a source of elastic vibrations causing the crystal

to heat up. Available data on the low-temperature behavior are extrapolated to very high annihilation temperatures, using a nonlinear equation of heat conduction with a variable thermal conductivity and the equation of defect (Frenkel pair) annihilation with or without diffusion taken into account. The solution yields a threshold defect density at which chain annihilation of Frenkel pairs will begin. This can occur in crystals with a sufficiently high energy of atom displacement into interstices, a low annihilation barrier, and an anomalously high frequency of transitions. Figures 2; references 14: 7 Russian, 7 Western.
[249-2415]

EFFECT OF STRONG ELECTRIC FIELD ON EXCITON ABSORPTION SPECTRUM IN GaP CRYSTALS

GLINSKIY, G. F., Leningrad Institute of Electrical Engineering imeni V. I. Ul'yanov (Lenin)

[Abstract] The spectrum of electroabsorption in GaP crystals near the indirect threshold is analyzed, taking into account the intricacy of exciton bands. Calculations are based on the equation of effective mass. The probability of indirect optical exciton transitions in the multiband model is calculated, assuming a two-particle exciton state and including electron-photon as well as electron-phonon interaction. In the specific case of GaP one needs to consider only virtual states, with smallest energy gaps and allowed transitions in the first order, one can also assume a complete wave function. On this basis, in the spherical approximation, the Schroedinger equation is solved for an indirect exciton in an electric field. Separation of variables is possible in a parabolic system of coordinates. Results for the state with the magnetic quantum $m = 0$ in strong electric fields, up to 10^4 V/cm, have been obtained by numerical solution. They agree closely with experimental data on electroabsorption at 4.2 K in GaP near the threshold of LA-phonon emission. The author thanks B. N. Shalayev and A. I. Sokolov for discussing several of the problems here, also I. I. Parfenov for assisting with computations. Figures 4; references 19: 12 Russian, 7 Western.
[249-2415]

TELLURIUM-DOPED GaSb CRYSTALS UNDER HYDROSTATIC PRESSURE

BOL'SHAKOV, L. P., YERMAKOVA, N. G., KOMOVA, E. M., LITVIN-STASHEVSKA, Ye., FILPCHENKO, A. S. and CHAYKINA, Ye. I., Physical Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] The pressure dependence of the Hall coefficient was measured on four specimens of GaSb crystals doped with tellurium to free-electron concentrations within the $(8.7 \cdot 10^{17} - 1.45 \cdot 10^{18})$ cm^{-3} range. As the hydro-static pressure increases, the Hall coefficient increases to a maximum at approximately 8 kbar in each case and then decreases until above 10 kbar it becomes smaller than at atmospheric pressure. This saturation at high pressures is explained by congregation of all electrons in L-valleys, while at atmospheric pressure there are electrons in L- and -valleys. On the basis of these data is calculated the dependence of the Hall coefficient on the L-electron concentration, also the distance between L- and -valleys at atmospheric pressure as well as the rate at which L- and -peaks come closer together with increasing pressure. Figures 1; tables 1; references 3: 2 Russian, 1 Western. [249-2415]

DISPERSION RELATION FOR PIEZO-OPTICAL CONSTANTS OF GaAs AND GaP

YAS'KOV, A. D., Leningrad Institute of Precision Mechanics and Optics

[Abstract] The dispersion relation $C(\hbar\omega)$ for the piezo-optical constants of GaAs and GaP near the edge of intrinsic absorption is calculated without the aid of curve fitting additional parameters on the basis of a semiempirical model in a linear approximation, with respect to mechanical stresses, for $A^{III}B^V$ compounds with a sphaleritic structure. The strain potential con-stant for interband optical transitions is calculated from experimental data on GaAs and GaP as well as on AlSb, GaAs, InSb and InP. The dispersion parameters $<A>$ and G_1 are calculated from data on dispersion of longitudinal and transverse refractive index in $A^{III}B^V$ compounds. The dispersion of the piezo-optical constants is also measured in high-resistivity single crystals at 297 K. Figures 1; references 8: 3 Russian, 5 Western. [249-2415]

EFFICIENCY OF RADIATIVE ACTION OF 3-1000 MeV ELECTRONS ON SILICON

MASLOV, N. I., PUGACHEV, G. D. and KHEYFETS, M. I., Khar'kov Physico-
Technical Institute, UkSSR Academy of Sciences

[Abstract] The behavior of semiconductor materials in radiation fields
depends on the efficiency of radiative action, particularly by relativistic
electrons. The lifetime of excess charge carriers is most sensitive to
the concentration of induced defects, the change in the reciprocal of this
lifetime being proportional to the cumulative radiation dose. The propor-
tionality factor or coefficient of radiative defectiveness has been measured
by various methods applicable to narrow ranges of electron energy. Here this
relation is measured for silicon with bombarding by 3-1000 MeV electrons
at 300 K, in pulses of 0.5 microsecond duration with a repetition rate of
50 Hz. The lifetime of excess charge carriers is determined from the drop
of photoconduction current pulses due to excitation by accelerated electrons,
taking into account the dependence of this lifetime on the excitation
intensity and its independence of the initial electron concentration in
silicon below a threshold level. The experimental data are compared with
calculations based on the model of elastic electron scattering by nuclei
and on the Mott equation for the scattering cross section. As the energy
of bombarding electrons increases above 100 MeV, the calculated defective-
ness cross section remains constant but the measured efficiency of defect
formation increases, probably because of attendant inelastic electron-
nucleus interaction. The authors thank V. A. Yamnitskiy, A. M. Vaysfel'd
and E. A. Reznichenko for assisting in the study and discussing the
results. Figures 2; references 10: 9 Russian, 1 Western.
[249-2415]

INFRARED ABSORPTION BY RADIATIVE DEFECTS IN ALUMINUM-DOPED SILICON

LAPPO, M. T., SURGANOVA, T. F., TADEUSH, N. N. and CHERNYY, V. V.,
Belorussian Polytechnic Institute, Minsk

[Abstract] The authors have detected 469, 431, 242 cm^{-1} bands in the
infrared absorption spectrum of silicon crystals doped with aluminum, the
first two caused by vibrations of paired Al_s^- and the third one caused by
vibrations of Al_i^{++}. Specimens of silicon crystals are doped with aluminum

or boron during the pulling process, to an initial electrical resistivity of approximately 0.02 ohm·cm, then irradiated with neutron fluxes of $5 \cdot 10^{17}$ and 10^{18} cm^{-2} from a reactor. Measurements were made in the 2-25 micrometer range of wavelengths at 300, 80 and 20 K. The infrared absorption spectrum of Si < Al > differs from that of Si < B > by having new bands on the background of a much weaker 3.9 micrometer band and by not containing the 3.61 and 3.45 micrometer bands. In Si < Al > absorption near the edge of the dominant band increases sharply after isochronous annealing at 250°C and absorption by free charge carriers occurs after annealing of disorder domains at 350°C. Figures 1; references 6: all Western.
[249-2415]

STRUCTURE AND DIMENSIONS OF DEFECT-BUILDUP REGION IN PROTON-IRRADIATED N-TYPE SILICON

KUZNETSOV, V. I. and LUGAKOV, P. F., Scientific-Research Institute of Problems in Applied Physics imeni A. N. Sevchenko, Minsk

[Abstract] A study is made of the defect-buildup region in silicon irradiated with protons. Specimens of weakly compensated n-type crystals with an initial electrical resistivity of 3-500 ohm·cm are pulled by the Czochralski method and by zone refining with oxygen concentrations $\gtrsim 8 \cdot 10^{17}$ cm^{-3} and $\lesssim 10^{16}$ cm^{-3}, respectively. They are irradiated with 660 MeV protons at $T \lesssim 50°C$ and, for comparison, with gamma quanta from a Co^{60} source. The temperature dependence of the Hall coefficient is then measured over the 78-400 K range. On the basis of these measurements the temperature dependence of the charge carrier concentration in irradiated specimens and the energy bands are determined. From experimental data and by calculations based on the Poisson equation the dimensions of the radiative defect-buildup region are now determined, assuming this region to be spherical, i.e., the average radius r_1 of its E-centers core (ionization of vacancies) and the average width r_2 of its A-centers envelope (impurity defects). In both kinds of crystals $r_2 > r_1$. As the initial donor concentration n_0 increases, over the $10^{13}-10^{15}$ cm^{-3} range, r_1 remains almost constant in pulled crystals and decreases in zone refined crystals. In both kinds of crystals r_2 does not depend on n_0, but it is approximately twice as large in zone refined ones as in pulled ones. Annealing of defects is found to occur in one stage in pulled crystals (320-380°C) but in two stages in zone refined crystals (250-300°C and 320-380°C). Figures 3; references 13: 8 Russian, 5 Western.
[249-2415]

116

TENSOELECTRIC EFFECTS IN IRRADIATED SCHOTTKY-BARRIER GaAs DIODES

VYATKIN, A. P., MAKSIMOVA, N. K. and FILONOV, N. G., Siberian Physico-
Technical Institute imeni V. D. Kuznetsov, Tomsk State University, Tomsk

[Abstract] An experimental study is made to determine the effect of radiative
defects caused by irradiating high-energy electrons on the sensitivity of
Schottky-barrier GaAs diodes to deformation (pressure). Specimens of
Pd-GaAs structures with rectifying junctions are electrodeposited of n-GaAs
with a charge carrier concentration $n_0 \sim 1 \cdot 10^{16}$ cm^{-3} on wafers with a (100)
orientation. The defect concentration is varied by increasing the irradia-
tion dose: $(3,6,8) \cdot 10^{15}$ cm^{-2}. Hydrostatic pressure up to 5.5 kbar is
applied to the specimens in a special chamber with transformer oil. The
height of the rectifying potential barrier is determined from the current-
voltage characteristics, the relative tensosensitivity is calculated for
various forward and reverse bias voltages. Before irradiation the tenso-
sensitivity of both forward and reverse current is independent of the bias
voltage. After irradiation the tensosensitivity of both currents is lower
and depends on the bias voltage in an intricate manner determined by the
degree of compensation, which increases with increasing irradiation dose,
and by the correspondingly increasing probability of resonant electron
tunneling in addition to regular thermoelectron emission. Figures 9;
references 9: 6 Russian, 3 Western.
[249-2415]

EFFECT OF NEUTRON IRRADIATION ON MAGNETIC SUSCEPTIBILITY OF SILICON CRYSTALS

ZAITOV, F. A., LITOVCHENKO, P. G., TSMOTS', V. M., KHIVRICH, V. I.,
SHIKHARDIN, Ya. G. and KOBETSKIY, R. Z., Drogobych Pedagogical Institute
imeni I. Franko

[Abstract] Measurement of magnetic susceptibility was used for study of
defects produced in silicon crystals by transmutational doping through
irradiation with thermal neutrons. Two groups of p-Si single crystals are
grown by the Czochralski method, with initial hole concentrations of
$4 \cdot 10^{15}$ and $2 \cdot 10^{16}$ cm^{-3}, respectively, with a hole mobility of 300-400 cm/V·s
and dislocation density of 10^4 cm^{-2} in both. All specimens were irradiated
with thermal neutrons (2.5% fast neutrons) from a reactor in doses of
$2 \cdot 10^{19}$ and $9 \cdot 10^{20}$ cm^{-2} respectively. The magnetic susceptibility is measured

by the Faraday method at room temperature. It is found to be independent of the magnetic field intensity, but to decrease after irradiation slightly (2-3%) in the first group and appreciably (10-15%) in the second group. Isochronous annealing for 20 min at temperatures up to 800°C caused the diamagnetism of irradiated crystals in both groups to increase and their magnetic susceptibility to become field dependent. This indicates a paramagnetic nature of radiative defects, which is further confirmed by a residual paramagnetism and a residual weak field dependence after annealing at 800°C. Some radiative defects remain unannealed at this temperature, as in the case of "oxygenous" silicon. Figures 2; references 6: 4 Russian, 2 Western. [249-2415]

EFFECT OF INDIUM ON ELECTRICAL PROPERTIES OF GaAs SINGLE CRYSTALS

SOLOV'YEVA, Ye. V., MIL'VIDSKIY, M. G., OSVENSKIY, V. B., BOL'SHEVA, Yu. N., GRIGOR'YEV, Yu. A. and TSYGANOV, V. P., State Scientific Research and Design Institute of the Rare Metals Industry, Moscow

[Abstract] A study is made of the electrical properties of GaAs single crystals doped with isovalent indium. The specimens are grown by the Czochralski method in a flux bed. The doping impurity is injected as the InAs compound, with the concentration of indium atoms varying from $7 \cdot 10^{19}$ to $5 \cdot 10^{21}$ cm^{-3}. The electrical resistivity is found to remain high (10^7-10^9 ohm·cm) over a wide range of indium concentrations ($2 \cdot 10^{19}$-$2 \cdot 10^{20}$ cm^{-3}), while the electron mobility varies from 2600 to 7000 cm^2/V·s. It remains high after annealing at 900°C in a hydrogen atmosphere or in sulfur vapor, indicating a high thermal stability of the material. It drops sharply at indium concentrations below $2 \cdot 10^{19}$ cm^{-3} and above $2 \cdot 10^{20}$ cm^{-3}. The temperature dependence of the electron concentration and of the Hall effect in high-resistivity GaAs doped by In is also measured. The dislocation density is found to be minimum in GaAs crystals with indium concentrations of $(2-5) \cdot 10^{19}$ cm^{-3}, higher concentrations resulting in impurity inhomogeneities. The lattice period obeys the Vegard law without anomalies and, therefore, no additional defects form caused by breakup of supersaturated solid solution of excess gallium. The authors thank S. P. Grishina for performing the heat treatment and measuring the dislocation density. Figures 2; tables 1; references 5: 3 Russian, 2 Western. [249-2415]

PROPERTIES OF NICKEL-DOPED SILICON UNDER LARGE DOSES OF GAMMA-IRRADIATION

BAKHADYRKHANOV, M. K. nad TALIPOV, F. M., Tashkent State University imeni V. I. Lenin

[Abstract] The behavior of neutral nickel impurity in silicon under large doses of gamma irradiation is studied in both p-type and n-type silicon with an electrical resistivity of 40-200 ohm·cm. Layers of metallic nickel are deposited at 1000-1250°C in an argon atmosphere. The specimens are then irradiated in air at not more than 100°C from a Co^{60} source with an intensity of $3 \cdot 10^3$ R/s. The results reveal that p-type crystals remain and n-type crystal become p-type ones after irradiation, the hole concentration increasing as the nickel concentration increases. The temperature dependence of the Hall effect and the photoconduction spectra reveal unambiguously that heavy irradiation does not produce new levels but increases the concentration of electrically active nickel atoms which produce E_c-0.2 and E_c-0.4 eV acceptor levels in silicon. Annealing at 450-500°C for several hours restores the initial electrical properties of irradiated silicon but does not change the electrical properties of irradiated Si<Ni>.
References: 2 Russian.
[249-2415]

APPROXIMATE METHOD OF THEORETICALLY SIMULATING ION IMPLANTATION

SUPRUN, A. D., FEDORCHENKO, A. M. and KHROMYAK, K. Ya., Kiev State University

[Abstract] Simulating ion implantation into a semiconductor theoretically is an economical way to predetermine the process conditions which will yield the necessary properties of the doped region. One approximate method of simulating the ion concentration profile is evaluating the integral in the profile equation by way of the steepest descent and the use of a corresponding exponential kernel, for determination of the ion path and straggle. Results are shown for polyenergetical ions of five kinds (B, P, S, As, Sb) in four different target materials (Si_3N_4, SiO_2, Si, GaAs). The results are also compared with those obtained by numerical integration. The method is applied to the typical case of a step profile. Figures 3; tables 1; references 8: 4 Russian, 4 Western.
[250-2415]

POSSIBILITIES, LIMITATIONS AND PROBLEMS IN DEVELOPMENT OF PLANAR WAVEGUIDE
OPTICS

DERYUGIN, L. N.

[Abstract] A review is presented of achievements and limitations discovered
in planar waveguide optics over its 15-year development history. Problems
facing planar waveguide optics today and possible ways of solving them are
discussed. The key advantages of planar waveguide optics over traditional
3-dimensional optics are discussed, as well as the new potential capabili-
ties which this field has revealed for the creation of optoelectronic inte-
grated circuits. The field of planar optics is occupied with questions
relating to the generation, propagation, conversion and reception of light
in planar optical waveguides and with the application of these waveguides
in optical devices. The subject of planar optics is light flux concen-
trated in very thin film-type waveguides formed by means of an insulator
or semiconductor layer having a refractive index greater than that of the
substrate supporting it. It is possible to construct film-type planar
analogues of all the basic elements of 3-dimensional optics, because
sections of planar waveguides having a specific configuration and being made
of the appropriate materials can perform the functions of optical and opto-
electronic elements and units. It is possible to create optical waveguide
circuits which are similar to microwave circuits. The limitations of planar
optics are caused by the fact that optical radiation is confined to a thin
waveguide layer in which it repeatedly interacts with the material and
boundaries of the layer. These limitations are associated with the 2-
dimensional nature of planar optics, optical losses, spaital noise, spatial
phase flucturations and the lack of a general-purpose material. Among the
unsolved problems of planar optics are that of reducing spatial phase
fluctuations, reducing optical losses from scattering in inhomogeneities
and the spatial noise associated with them, and establishing optimum levels
for the integration and hybridization of planar optical devices taking into
account the real capabilities of materials and the technology. It is
necessary to solve problems in effectively joing hybrid elements. The main
problem here is effectively joing a laser radiation source with the remaining
part of the integrated circuit. All these problems are basically of a
technological nature and can be solved only by the realization of very high
specifications with regard to the purity and homogeneity of the materials
of films and substrates, cleanliness and uniformity in treating the surfaces
and forming the boundaries of planar elements, accuracy in reproducing the
dimensions and parameters of elements and accuracy in arranging and inter-
facing hybrid elements. Integrated optics at the present time has borrowed
its technological methods chiefly from microelectronics and 3-dimensional
optics, but these methods in a number of instances do not satisfy the stricter
specifications of integrated optics. Figures 9; references 49:
39 Russian, 10 Western.
[218-8831]

PHOTOELECTRIC AMPLIFIER OF NANOSECOND PULSES

AVER'YANOV, G. A., SAVICHEV, B. M. and PROSHINA, V. S.

[Abstract] A wideband photoelectric amplifier has been developed for 10 ns
optical pulses with repetition rates up to 50 MHz. The input stage includes
a LFD-2 photodiode, with a KP303G field-effect transistor and a KT368 bi-
polar transistor in the common-emitter common-collector connection. There
follow an i-f stage and an h-f stage, both built with 228UV2 microcircuits,
a 2-Kohm potentiometer in the i-f stage included for gain control. The
nominal gain is 200, with a 20 dB regulation. The output stage, matched to
the h-f stage through an emitter follower with a KT363B high-frequency
p-n-p transistor, consists of two such KT363B transistors in parallel.
Nonlinear distortion is minimized by raising the supply voltage to +8.0 V
from the conventional +6.3 V across the microcircuits at full load. All
components, including conventional radioelectrical elements (resistors,
capacitors, diodes), are mounted on one side of a bilaterally clad 150x50 mm^2
large and 1.5 mm thick glass-Textolite printed-circuit board with the other
side grounded. The amplifier can handle input pulses with amplitudes up to
4.0 V, its noise level referred to the input is 40-50 microvolt. It operates
with a 75-ohm matching cable, but can also operate with a 60-ohm matching
cable to the load at a signal level reduced to 67%. Figures 1;
references: 3 Russian.
[241-2415]

DIFFRACTION METHODS FOR DETERMINING SPREAD OF LINEAR DIMENSIONS OF TOPOLOGY
ELEMENTS OF LARGE INTEGRATED CIRCUITS

KAPAYEV, V. V.

[Abstract] With the increase in the degree of integration, the requirements
on the precision of fulfillment of the dimensions of microcircuit elements
have increased considerably. In this connection the necessity arises to
check not only reproduction of the dimensions of elements on wafers, but
also the spread of dimensions within an individual crystal, because the
magnitude of this spread precisely determines the probability of fitness
for work of the circuit arranged on the crystal in question. In order to
evaluate the spread it is necessary to perform a number of measurements on
one crystal. The present work theoretically shows that a diffraction grating

is a suitable test object which makes it possible simultaneously to measure
the mean value and the spread of the linear dimensions of the elements of
the microcircuits. With a sufficiently large number of rules in the grating,
the intensity of light diffraction in the direction of the principal maximums
weakly depends on the concrete form of distortion of the regular structure
of the grating, determined basically by the magnitude of the deviation of
the dimensions from the mean value. Figures 2; references 3: 2 Russian,
1 Western in translation.
[137-A-6415]

INVESTIGATION OF VOLT-AMPERE CHARACTERISTICS OF MIS STRUCTURE BASED ON GaAs

DMITRUK, N. L., ZYUGANOV, A. N. and MAYEVA, O. I., Institute of Semiconductors,
UkSSR Academy of Sciences

[Abstract] The present brief communication is devoted to an investigation
of the electrical conductivity of thin ($\sim 10^{-5}$ cm) dielectric layers of
Ge_3N_4 entering into a metal-insulator-semiconductor [MIS] structure based
on GaAs, which is promising for creation of a whole series of microelec-
tronic devices. The method of obtaining layers of Ge_3N_4 is explained.
The volt-ampere characteristics of the structure In-GaAs-Ge_3N_4-Al were
obtained at room temperature (T $\sim$ 300°C) at forward (plus at Al) and
reverse (plus at In) biases. Some of these characteristics are presented
in Figure 1 of the text. Domination of the mechanism of current limitation
by a space charge, localized mainly at deep-seated (08 eV) levels with a
high (10^{17} cm^{-3} with $\varepsilon \sim$ 10) concentration is shown. Figures 2; tables 1;
references 13: 11 Russian, 2 Western.
[137-A-6415]

FEATURES OF CHARGE GENERATION IN CHARGE-COUPLED DEVICE WITH MACROSCOPIC DEFECTS

KLYAUS, Kh. I., SEVAST'YANOV, S. B., SERDYUK, Yu. N. and CHEREPOV, Ye. I.,
Institute of Semiconductors, Siberian Department, USSR Academy of Sciences

[Abstract] The present brief communication considers some special features of the process of thermal generation in charge-coupled devices [CCD] which have macroscopic defective sections comparable in their dimensions with the dimensions of a metal-insulator-semiconductor cell. These special features can appear in the form of anomously high rates of charge generation and peaks at the generation curve dQ_p/dt. The investigations were conducted on three-phase 64-digit CCD-shift registers, fulfilled on the basis of structure of semiSilicon-Si_3N_4 (700 Å)-SiO_2 (1200 Å)-Si (KEF-7.5) [100] with the length of the transmitting electrode of ~13.5 micrometer and a clearance between them of ~1.5 micron. It is shown that the presence of anomolous cells correlates with the occurrence in the substrate of macroscopic defective sections with an increasing degree of doping, formed as the result of nonqualitative processing of the initial wafers. Some special features of the generation process in CCD-cells with heterogeneous parameters are considered. Figures 4; references 12: 9 Russian, 3 Western.
[137-A-6415]

CHARACTERISTICS OF MICROWAVE MIXERS BASED ON SCHOTTKY BARRIER DIODES

PETROV, G. V., Engineering Physics, Institute, Moscow

[Abstract] Schottky barrier diodes are the basic elements of any microwave mixer and exert considerable influence on its output characteristics. Because there is a considerable variation in the parameters of all semiconductor devices, considerable difficulties originate in determining their parameters in the development of mixers. Computer simulation must be employed instead of experimental modeling. A study is presented here of the frequency characteristics of Schottky diodes and of mixers based on them and of methods of studying these characteristics. Diodes based on GaAs surpass by approximately an order of magnitude in terms of maximum operating frequencies diodes based on Si. When GaAs diodes are used in wideband mixers the mixer's noise factor drops by 1 dB as compared with using Si diodes.

Si Schottky diodes have definite advantages when there are limitations on the power of the local oscillator. The equivalent circuit is presented which is used to determine the characteristics of a mixer and includes the circuit of the local oscillator and the equivalent circuit of the diode. The local oscillator is a voltage generator with a frequency-independent output impedance. The admittance of the Schottky diode is found and on its basis a determination is made of coefficients of the conductance matrix which relate low-signal currents and voltages in the mixer. In order to calculate a mixer's parameters a determination is first made of the frequency dependences of the diode's admittance, the voltage standing wave ratio, and the rectified current. Curves are shown, illustrating the dependence of the first-harmonic input conductance on frequency for Schottky diodes based on Si and GaAs. It is shown that the magnitude of the rectified current is higher for a GaAs Schottky diode than for a silicon. In designing Schottky diodes it is necessary to strive to reduce the value of R_s, representing the resistance of the linear section of the diode's equivalent circuit. R_s reduces the rectified current. By using the equivalent circuit presented for a Schottky diode, it is possible to determine the influence of variation in the parameters of a diode on its characteristics. It is shown that in the 6 to 12 GHz frequency band the parameters of mixers using silicon Schottky diodes are somewhat worse than those using GaAs diodes. This factor is compensated, however, by the fact that it is simpler to fabricate silicon diodes and their reliability is better than that of GaAs diodes. Silicon Schottky diodes are to be preferred when the power of the local oscillator is restricted. Figures 6; references 9: 8 Russian, 1 Western.
[210-8831]

UDC 621.382

PHOTOELECTROMOTIVE FORCE BARRIERS OF HgCdTe MOS STRUCTURES

Moscow MIKROELEKTRONIKA in Russian Vol 11, No 1, Jan-Feb 82
(manuscript received 25 Feb 81) pp 70-73

ANTONOV, V. V., VOYTSEKHOVSKIY, A. V., KAZAK, Ye. P., LANSKAYA, O. G. and PLOMIPU, B. G., Siberian Physicotechnical Institute

[Abstract] The results are given of a study of the production of MOS (metal oxide semiconductor) structures based on the compound HgCdTe with an anode oxide film, and of their photoelectric properties, i.e., the dependence of the barrier photoelectromotive force on the bias voltage in the field-effect electrode and on the temperature. The surface of n- and p-type chips with random orientation was anodized after chemical treatment in an electrolyte consisting of a 0.1 N solution of KOH in ethylene glycol. MOS structures were produced by spraying semitransparent N_1-electrodes 0.5 X 0.25 mm^2 through a metallic mask onto an anode oxide film of HgCdTe. Capacitance-voltage characteristics of the MOS structures were obtained with

a test signal amplitude of approximately 3 mV at an operating temperature of 80 °K. Curves are shown, illustrating the dependence of the photo-e.m.f. and capacitance on the bias voltage in the field-effect electrode with incident radiation with wavelength of 3.39 microns for various specimens. The photoelectric characteristics of MOS structures based on HgCdTe were studied for optical radiation wavelengths of 1.15, 3.39 and 10.6 microns at a modulation frequency of approximately 1.5 kHz at an operating temperature of approximately 80 °K. The photo-e.m.f. signal was amplified by a low-noise amplifier with a high-impedance input (approximately 1 MΩ), an approximately 200 kHz transmission band and gain of approximately 10^3, and the barrier photo-e.m.f. was measured with a low level of photoexcitation. The dependence of the barrier photo-e.m.f. on temperature is shown for a structure fabricated from p-HgCdTe with a depletion bend in regions on the surface with a bias voltage in the field-effect electrode of zero. With an increase in operating temperature the concentration of electrons increases, resulting in a change in the position of the Fermi level, which moves toward the conduction band. With this the surface changes from a state of depletion to inversion and the value of the photo-e.m.f. increases when the temperature is equal to or greater than 150 °K. The photo-e.m.f. drops suddenly on account of the formation of an enriching bend in regions on the surface at equal to or greater than 230 °K when the semiconductor in the surface region acquires n-type conduction. Passivation with an anode oxide apparently reduces the recombination rate on the semiconductor's surface. The spectral characteristics of the photoconductivity of MOS structures based on HgCdTe have a smoother rise in the shortwave region than those of the starting chips. Figures 3; references 12: 5 Russian, 7 Western.
[210-8831]

ACTIVATION OF DOPING IMPURITY BY MEANS OF LASER RADIATION IN THIN SURFACE LAYERS OF OXIDIZED SILICON IMPLANTED WITH BORON IONS

LYSENKO, V. S., NAZAROV, A. N. and LOKSHIN, M. M., Institute of Semiconductors, Ukrainian SSR Academy of Sciences

[Abstract] The results are given of a study of the influence of pulsed laser radiation on the process of activation of an ion-implanted boron impurity in Si-SiO$_2$ structures, as well as on the properties of SiO$_2$ films. A film of SiO$_2$ 1500 Å thick was grown at 1150 °C in an atmosphere of dry oxygen on n-Si specimens with resistivity of 4.5 $\Omega \cdot$cm. B$^+$ ions with energy of 40 keV were implanted into the structure through the oxide film in a dose of $1.25 \cdot 10^{12}$ cm^{-2}, half of the wafer being covered with a shield to produce a control specimen. Sections measuring 0.5 cm^2 on the surfaces of the control and implanted specimens were exposed to the nonfocused

pulses of a Q-switched ruby laser with a pulse length of 50 ns and the strength of the incident radiation varying over the range of $(0.9 \text{ to } 2.4) \cdot 10^7$ W/cm^2. The maximum in the distribution of the concentration of the introduced impurity was near the insulator-semiconductor interface. The heat-stimulated depolarization and high-frequency volt-farad characteristic methods were used to monitor the change in the electrophysical properties of the structures. Heat-stimulated depolarization measurements were made in the temperature range of 300 to 450 °K while heating linearly at a rate of 0.5 °K/s. It was found that the effect of the radiation of a ruby laser pulse with power of $1.6 \cdot 10^7$ W/cm^2 corresponds to thermal annealing for 20 min at 620 °C, and with power of $2.3 \cdot 10^7$ W/cm^2, at a temperature of 730 °C. Laser irradiation results in a drop in the maximum capacitance of structures and in substantial lessening of the curvature of volt-farad characteristics. The effect of laser pulses results in considerable worsening of the electro-physical characteristics of the insulator. Responsible for worsening of the dielectric properties of SiO_2 films in the original structures is the temperature gradient at the insulator-semiconductor interface, which origin-ates in the absorption of laser radiation in the thin surface layer of silicon. If absorption in the SiO_2 film is negligibly low and the tempera-ture in a film approximately 1 micron thick reaches 1000 °C in approximately 100 ns, representing a state of thermal shock, this can result in thermo-mechanical stresses in the insulator-semiconductor interface and the forma-tion of micropores and other imperfections in the insulator film. However, the influence of thermal shock here is reduced and partial annealing of defects in the insulator takes place because of the absorption of laser radiation in defects and in the introduced boron impurity in the oxide after implantation. Figures 3; references 11: 7 Russian, 4 Western. [210-8831]

TWO-PROBE METHOD OF INVESTIGATION OF THYRISTOR TURN-ON PROCESS

KROGERIS, A. F., RASHEVITS, K. K. and SHINKA, Ya. K., Physics and Power Engineering Institute, LaSSR Academy of Sciences

[Abstract] In order to study the turn-on process in series-produced power transistors, the use is suggested of special probes which are widely used in electrical engineering for measurement of the distribution of current in massive conduction elements of electrical machines and equip-ment. The following items are considered in the present paper: 1) Basis of method of experimental determination of current-conduction region [CCR]; 2) Basic position of two-probe method; and 3) Investigation of process of extension of CCR in the thyristor structure. Experimental curves are plotted to show the variation in potential difference across a model and a

real thyristor. It is concluded that by means of an approximate theoretical analysis of the distribution of the current density in a thyristor structure, a connection is established between signals of the voltage measurable at the probes and the components of the current density in the anode part and the silicon plates of the structure. The results obtained are confirmed by a physical model of the structure. The possibility is shown of using the two-probe method for determining the location of the initial region of turn-on, the rate, the current density and the limits of extension of the CCR in the structures of power thyristors of industrial output with any form of anode current. Figures 6; references 7: 6 Russian, 1 Western. [177-6415]

LOW-FREQUENCY FLUCTUATIONS IN GaAs AVALANCHE TRANSIT TIME DIODE

KORNILOV, S. A. and PAVLOV, V. M.

[Abstract] An experimental investigation is made of a one flight-path gallium arsenide transit time diode oscillator [ATDO] with a Schottky barrier and a plane section of doping and a range of 10 GHz. The object of the investigation is to obtain information concerning a source of flicker noise and its effect on the oscillations generated. The authors conclude that the flicker component of the frequency fluctuations in a gallium arsenide ATDO with a uniform doping section does not result from modulation of the frequency by noise of the diode current. A source of flicker noise exists which directly influences the frequency of oscillations and appears comparatively weakly in the diode current. These concepts make it possible to develop a phenomenological model. In general outline, it accurately reflects the correlative connection of the frequency fluctuations and current in the ATDO. Additional investigations are necessary in order to determine the physical nature and localization of flicker noise. The authors thank E. A. Gel'vich, V. M. Val'd-Perlov and L. S. Sibirtsev for assistance in organizing the work. Figures 3; tables 2; references 7: 6 Russian, 1 Western. [88-6415]

OBTAINING ELEMENTS OF SUBMICRON DIMENSIONS IN FILMS OF VARIOUS MATERIALS BY
REACTIVE ION-BEAM ETCHING

KIREYEV, V. Yu., KUZNETSOVA, V. V., LAVRISHCHEV, V. P., MAKHOV, V. I.
and YASTREBOV, V. G.

[Abstract] In order to evaluate the real possibilities of obtaining in a
substrate, elements of submicron linear dimensions with specific geometri-
cal parameters, it is necessary to have analytical dependences connecting
these parameters with the angle of slope of the border of the elements in
the mask and the selectivity of the etching process. The present work is
devoted to the derivation of such analytical dependences as well as their
experimental verification with the use of electron lithography at the stage
of obtaining an image in the mask and reactive ion-beam etching during
transfer of the image to the substrate surface. The basic theory and the
experimental procedures are explained. It is concluded that theoretical
consideration of the process of transfer of an image through a masking
coating on the surface of a substrate by etching it by an accelerated
stream of the ions of chemically active gases makes it possible to connect
the geometrical parameters of the elements obtained (angle of slope of
border), maintenance of linear dimensions with respect to the dimensions
of the elements in the masking coating and the selectivity of the etching
process. The reactive ion-beam etching gives a more favorable (monotoni-
cally decreasing) angular dependence of the rate of etching of the materials,
from the point of view of obtaining elements of submicron linear dimensions,
than does ion-beam etching. An experimental study of the process of ob-
taining elements of submicron linear dimensions with the use of electron-
beam exposure (during formation of a design in the masking coating) and
reactive ion-beam etching (during transfer of an image onto the surface
of a substrate gave results which agree well with theory. The authors
thank T. G. Nesterov and A. K. Kebirov for assistance in preparation of
specimens. Figures 5; tables 1; references 10: 6 Russian, 4 Western.
[137-A-6415]

APPROXIMATE NONLINEAR ANALYSIS OF NOISE AMPLIFICATION IN O-TYPE TRAVELING-
WAVE TUBE

LAZERSON, A. G. and MAN'KIN, I. A.

[Abstract] The paper is concerned with the development of an appropriate
method for nonlinear analysis of noise amplification in a traveling-wave

tube [TWT]. The object of this is to clarify the basic regularity of the process as well as to obtain relatively simple analytical formulas, suitable for calculation of the characteristics of the noise at the output of the TWT. The authors conclude that the method developed for analysis of the amplification of a noise signal in a nonlinear regime makes it possible to obtain analytical formulas for a correlation function, and the spectral density of noise as a function of the parameters of a TWT. In contrast to earlier work described in the literature, the examination is conducted in time representation. This makes it possible to calculate the spectral density as a continuous function of the frequency. On the basis of the calculations illustrated it is shown that as the transition into a nonlinear regime proceeds, the bandwidth of the output of the TWT is expanded. It is necessary to take this into account during operation of a TWT in radio equipment. Figures 1; references: 7 Russian.
[88-6415]

129

DIGITAL FREQUENCY SYNTHESIZER WITH SEQUENTIAL BALANCING

ODINOKOV, V. F., Ryazan' Institute of Radio Engineering

[Abstract] Digital frequency synthesizers must feature a wide range of
electronic tuning and high accuracy of frequency setting as well as stability
and fast response of the automatic frequency control loop. These con-
flicting requirements can be largely reconciled by use of discrete electronic
commutation (with diodes) of the frequency-setting elements (inductances)
in the controlled oscillator and controlling this commutator, equivalent
to a code-to-analog converter, in the frequency-tracking mode through
sequential balancing of digits. Fine frequency setting is effected by means
of phase-tracking automatic frequency control. Both frequency control
loops are included in the structure of a digital frequency synthesizer,
which also contains a variable-ratio divider, a time discriminator, a pulse-
phase detector, and a reference oscillator with frequency divider. Transi-
tion from frequency-tracking mode to phase-tracking mode is effected with
minimum duration of transients. The paper was recommended by the Department
of Automated Control Systems. Figures 2; references: 6 Russian.
[202-2415]

OUTLOOK FOR DEVELOPMENT OF DIGITAL COMMUNICATION IN RAILROAD TRANSPORTATION
SYSTEMS

NEYMAN, V. I., doctor of technical sciences

[Abstract] The only way to meet increasing demands for communication
facilities with decreasingly available resources is through development of

new means of control and communication, which applies particularly to railroad transportation systems. Here innovation implies a changeover from analog to digital systems, specifically IKM (pulse code modulation) systems on account of their outstanding advantages. The major difficulties of such a changeover are those associated with coordinating the concurrent operation of both digital and analog equipment during the transition period, anticipated to be rather long. They include coping with interference between time-multiplexed and frequency-multiplexed signals in different conductor pairs in handling both systems. A technical-economic analysis indicates that installation of IKM-30 equipment in railroad transportation systems and operating it in accordance with ITTCC recommendations should be advantageous from the standpoint of both materials and energy consumption. These advantages can be pressed even further by use of fiber optics for transmission of digital signals. Figures 2.
[200-2415]

SYSTEM USL-79 OF SEMAPHOR CONTROL FROM LOCOMOTIVE

KAZAKOV, A. A., acting professor, Moscow Institute of Railroad Engineers, KOSENKOV, N. S., candidate of technical sciences, SHALYAGIN, D. V., candidate of technical sciences, and LYUBIMOV, A. V., engineer

[Abstract] System USL-79 for semaphor control from a locomotive is relatively simple in construction and ensures execution of all necessary maneuvers in small railroad yards with a few locomotives, more efficiently than the TMML-75 system used in large railroad yards. It is designed to operate either with a centralized electrical system or with a centralized routing system. It is built with small-scale and medium-scale circuit integration, laid out on four printed-circuit boards. The stationary components mounted on a post include a master pulse generator, a frequency divider, three shift registers, an encoder, a transmitter, a receiver with another shift register, a code checking matrix, a decoder, and four control-command commutators. The first shift register is a distributor to 4 outputs, assembled on one K155IR1 microcircuit. The second shift register is a distributor to 8 outputs, assembled on two K155IR1 microcircuits with four inverters and one OR circuit (K155LA7). The third shift register is a distributor to 32 outputs, assembled on eight K155IR1 microcircuits. The encoder is assembled on three K155LA7 microcircuits with two NAND circuits each. The receiver register consists of eight D-triggers (K155TM2). The decoder is assembled on four K155LI1 microcircuits. The control-command commutators are assembled on K155LA7 microcircuits, the signal commutator is assembled on elements of K155LA3-K155LN1-K155LA3 microcircuits. The system enables a locomotive to control 32 two-position objects and to monitor their state. Figures 5.
[200-2415]

INSTRUMENTATION & MEASUREMENTS

CEPSTRAL ANALYSIS AND SPECKLE INTERFEROMETRY OF BROADBAND IMAGES

AFRAYMOVICH, E. L.

[Abstract] Cepstral analysis has been developed as a basis for processing
of broadband images such as those of large celestial objects, and for the
purpose of compensating distortions after passage of optical signals through
an unsteady nonhomogeneous atmosphere. It is an extension of speckle inter-
ferometry used for processing of images of bright objects such as stars with
very small angular dimensions. It is also a variant of homomorphous fil-
tration, namely nonlinear transformation of the product or convolution of
signals into their sum, with possibility of subsequent linear filtration.
Cepstrum is the spectrum of the logarithm of the signal power spectrum,
which includes three components: coherent, noncoherent and noise. The
algorithm of two-dimensional cepstral analysis includes two Fourier trans-
formations with an intermediate logarithmic operation. Image restoration
is possible, after filtration, through two inverse Fourier transformations
with intermediate raising to a power. This technique can be useful for
study of twin or multiple stars as well as for evaluation of image quality
and telescope resolving power. Figures 3; references 12: 5 Russian,
7 Western.
[199-2415]

USING PECULIARITIES OF CONVOLVER OUTPUT SIGNALS FOR DETERMINING ARRIVAL
TIME OF COMPLEX INPUT SIGNALS

KUZICHKIN, A. V., Leningrad

[Abstract] Operation of acoustic convolvers for radio engineering measure-
ments, with countering ultrasonic analog of the input signal and ultrasonic

analog of the reference signal, is described and shown that it is possible
to determine the arrival time of a complex input signal from the parameters
of the output signal without search and synchronization procedures. The
method is based on matching the convolver interaction range with the dura-
tion of the complex input signal, then using the correlation peaks of suc-
cessive orders resulting from spatial coincidence of corresponding segments
of input signal and reference signal. The method is demonstrated on two
convolvers with a fixed time shift between their reference signals.
Figures 1; tables 1; references: 3 Russian.
[202-2415]

PERFORMANCE ANALYSIS OF A.C. PHOTOPOTENTIOMETERS

SKVORTSOV, B. V.

[Abstract] An a.c. photopotentiometer, a device consisting of a resistive
film between two electrodes and connected to the collector through a photo-
layer, is described by an equivalent circuit with a diode in the light-
probe region simulating the rectifier action of the junction between col-
lector and illuminated photolayer. It is also described by a mathematical
model in the one-dimensional approximation. The performance character-
istics of this device are calculated on the basis of a linearized current-
voltage characteristic of the photolayer capacitance. The theoretical
output characteristics at various input frequencies as well as frequency,
phase, and nonlinear distortion agree within 15% with experimental data.
In order to reduce these distortions, it is necessary to select photo-
potentiometer materials which will yield a smaller photolayer capacitance
and a linear current-voltage characteristic of the collector-photolayer
junction. The author thanks A. G. Rokakh and L. D. Zorina of the Saratov
State University for assisting in the preparation of photopotentiometer
specimens. Figures 5; tables 1; references: 5 Russian.
[203-2415]

ONE POSSIBILITY OF MEASURING LOW FREQUENCIES FASTER

SALAYEV, A. R., Azerbaijan Institute of Petroleum and Chemistry
imeni M. Azizbekov

[Abstract] In order to increase the speed of frequency measurement, it is
necessary to reduce the dynamic error. Here an algorithm of digital
measurement of low frequencies is described which involves encoding the
period and then subtracting a number N_T proportional to the period success-
ively from a number corresponding to the maximum frequency of the range and
to the required accuracy till a remainder is obtained. Afterwards this
number N_T is iteratively converted to a number N_F proportional to the fre-
quency, while the remainder is on each iteration shifted by one digit to
the left, and then the value of the period code is subtracted from that
remainder till a new remainder is obtained. The device for implementing
this algorithm consists of several counters, including a counter-divider
and a set of AND gates. The operation is illustrated on measurement of
frequencies in the 10^{-1}-10^1 Hz range within a 0.01% accuracy. The paper was
recommended by the Department (Kafedra) of Information-Measurement and
Computer Techniques. Figures 1; references: 1 Russian.
[202-2415]

ENTROPIC LATENCY OF EVENT

KANEVSKIY, Z. M., Voronezh Polytechnic Institute

[Abstract] The concept of potential or entropic latency is defined as a
quantitative measure of the difficulty in detecting an event or determining
a quantity. It is characterized by the minimum number of binary measure-
ments necessary to be made for disclosure. The concept and its application
in engineering are illustrated for the typical case of flaw detection,
where simultaneous events occur. Here all possible combinations of those
events are represented in the form of a rectangular BxA matrix with $B = 2^A$
rows. Its probability characteristics are established, and on their basis
the entropic efficiency of a measuring method or instrument as well as the
cost (in labor or time) of a binary operation are derived. The paper was
recommended by the Department (Kafedra) of Radio Engineering. Figures 2;
references: 3 Russian.
[202-2415]

'COMMUNICATION 81' EXHIBITION: MEASUREMENT TECHNIQUES

[Abstract] New instruments developed in the Soviet Union and shown at the International Exhibition "Communication 81" include voltmeters, oscillographs, electronic-counter frequency meters and signal generators for general or special applications, some with automation, also seven other devices: cable-embedment-depth meter, cable-insulation-fault locator, communication-cable router, crosstalk meter, automatic telephone-channel checker (net attenuation and psophometric noise), and generator-analyzer of logic signals for static and pulse testing.
[200-2415]

MAGNETICS

METHOD OF CONNECTING MAGNETORESISTIVE DOMAIN DETECTORS IN CYLINDRICAL-
MAGNETIC-DOMAIN DEVICES

RAYEV, V. K. and SHORYGIN, M. P., Institute of Electronic Control Machines

[Abstract] The performance of a cylindrical-magnetic-domain device for
data readout which consists of a herringbone expander and two magneto-
resistive herringbone detectors depends largely on how the two detectors,
main and compensating, are installed in the bridge circuit. If they are
both in one domain displacement tracking channel one space period of the
domain array apart ensures low interference caused by the unbalance between
them. If the main detector is inside the channel and the compensating
detector outside, recording of continuous domain sequences is facilitated.
A scheme is now proposed which combines the advantages of both. The two
detectors with an asymmetric topology are placed in the channel in a row and
oriented with their detecting wings in oppostion or, specifically, mirror-
image position. Experimental data obtained with cylindrical-magnetic-
domains 5 micrometer in diameter, a space period of 25 micrometer, and
detectors consisting of 120 herringbones (thickness 0.4 micrometer,
resistance about 320 ohm, current 4 mA) confirm the advantages of this
scheme, when the sensors of the two detectors are separated by a distance
equal to half the space period of the domain array or an odd multiple
thereof. Figures 2; references 3: 1 Russian, 2 Western.
[250-2415]

DYNAMICS OF REORDERING OF STRUCTURE OF HETEROGENEOUS THERMO-OPTICAL MEDIUM

KABYCHENKOV, A. F., Institute of Radio Engineering and Electronics,
USSR Academy of Sciences

[Abstract] A theoretical study is presented of the motion of magnetic
particles of micrometer dimensions in a viscous medium. The discussion
is limited to paired interactions and the shape of the particles is approxi-
mated by prolate ellipsoids of revolution and it is assumed that the particles
are magnetically anisotropic and that the easy axis is in line with the
ellipsoid's major axis. It is also assumed that the particles interact
with one another as point dipoles placed at the centers of spheroids, and
that the magnetization vector is always directed along the effective field,
$H_{eff} = H + H_a + H_g$, where H is the external field, which is generally in-
homogeneous, H_a is the anisotropy field and H_g is the field of the neighbor-
ing particle. It is further assumed that the motion takes place in an in-
finite incompressible Newtonian fluid and that the axes of anisotropy and
the magnetization vector and external field vector lie in the same plane.
Langrangian formalism is employed to derive equations of motion. The sys-
tem's Lagrangian contains terms which define the kinetic energy of trans-
lational motion and rotation, the energy of uniaxial anisotropy, the energy
of a particle in the external field, and the energy of magnetic dipole
interaction. A system of equations is derived which describes motion
representing the rotation of a particle to a position in which the axis
of anisotropy is in line with the direction of the magnetic field and trans-
lational motion is along the direction of the field's growth. This study
was prompted by the suggestion of a heterogeneous thermo-optical medium
for recording information, based on a magnetic dispersed medium consisting
of a transparent substance representing a binder capable of liquid-crystal
aggregation transformation, and of a filler in the form of nontransparent
magnetic particles. The particles are arranged chaotically in an unexposed
heterogeneous medium and the medium is practically nontransparent. In order
to record an optical signal the binder is transformed into the liquid state
under the effect of radiation absorbed by the heterogeneous medium's particles
and the magnetic particles are aligned into chains in the direction of an
external magnetic field parallel to the incident light flux. The recorded
image is fixed when the binder goes into the solid state. The theoretical
study presented analyzes the process of recording in a heterogeneous medium
of this sort. Figures 6; references 6: 3 Russian, 3 Western.
[210-8831]

TWO-DIMENSIONAL EFFECTS USED DURING SPACE CHARGE WAVES PROPAGATION IN THIN SEMICONDUCTOR FILMS FOR PROCESSING MICROWAVE SIGNALS

GUREVICH, G. L. and KOGAN, A. L.

[Abstract] Because of the rapid increase of the demand for devices used to process microwave signals, an investigation is of interest of physical phenomena, on the basis of which creation of new forms of such devices can be made. As shown in two previous papers (1979, 1980) by the authors, one of the promising directions for investigation is the use of two-dimensional effects during propagation of beams of waves of space charge [WSC] in thin semiconductor layers with drift electrons. In the present work a theoretical analysis is made of propagation in the units mentioned above of weakly polychromatic beams of WSC as well as consideration of the possibility of their use for space processing of frequency modulated microwave signals. A block diagram is presented of a device for processing microwave FM signals. The following items are considered in the work: 1) Green function for two-dimensional system in case of weakly polychromatic signal; 2) Space scanning of microwave radio signal in packet of space charge waves; 3) Selection of linearly frequency modulated signals of microwave band according to parameters of beams of WSC excitable by them; and 4) Limits of applicability of model. Figures 1; references: 2 Russian.
[88-6415]

PROPAGATION OF BEAMS THROUGH SMOOTHLY IRREGULAR WAVEGUIDES AND PERTURBATION
THEORY FOR HAMILTONIAN SYSTEMS

NEYSHTADT, A. I., All-Union Scientific Research Institute of Medical
Instruments

[Abstract] Propagation of beams through smoothly irregular plane waveguides
can be described by a Hamiltonian which is a function of the longitudinal
coordinate, this space coordinate being equivalent here to the time coordinate.
Such a Hamiltonian can be integrated approximately by application of the per-
turbation theory in action-angle variables. This method is much simpler than
asymptotic methods and the same for both refractive waveguides and wave-
guides with reflecting walls. The first step in solving the problem in
the case of a waveguide with a curvilinear axis is transformation of p,q
variables ($p-$ momentum, $2-$ length of normal to axis) to I, variables
($\varphi-$ angular coordinate along unperturbed trajectory, I- $1/2\pi$ times area
under unperturbed trajectory through point p,q). The next step is asymptotic
integration after another canonical near-identity transformation from I,φ
variables to J,ψ variables by means of a later determined generating func-
tion. The procedure and calculations are demonstrated on propagation through
a smooth transition between two regular waveguides. The procedure is ex-
tended to configuration of beams with swinging of action behind a transi-
tion of finite smoothness and behind an infinitely long transition with
analytical profile. The author thanks V. I. Arnol'd for proposing the
topic and V. A. Borovikov for his discussion and suggestions. Figures 3;
references: 17 Russian.
[201-2415]

DOUBLE-RESONANT WAVEGUIDE IRIS

ALYBIN, V. G., GORDYUKHINA, N. M., LEBEDEV, I. V. and FRADKIN, B. M.

[Abstract] The results are presented of theoretical and experimental
investigation of a new variety of multislot waveguide irises which have
resonances of parallel and series types. An electrodynamic solution of the
problem is given. It is shown that the calculations and experiments con-
ducted indicate the possibility of a sufficiently correct electrodynamic
description of a new variety of waveguide units--double resonant irises.

In the literature an effort is made to consider irises which have some
similarity to the units described in the present paper. However, the pro-
cedure used in them is limited considerably more by the coarse scope of
known concepts concerning the capacitance of the irises in a waveguide, and
does not make it possible fully to consider the properties of multislot
irises. The investigations conducted in the present paper develop the re-
sults of works in the literature and add to calculations based on the method
of equivalent circuits. The extent of calculations based on a system con-
taining control, lasing or amplifier microwave diodes is of interest.
Figures 6; references 4: 3 Russian, 1 Western.
[88-6415]

CONDITIONS FOR EXCITATION OF HIGHER-ORDER OSCILLATION MODES IN OROTRON

SOLOV'YEV, A. N. and TSEYTLIN, M. B.

[Abstract] Cutoff of the fundamental oscillation mode in microwave devices
such as the long-interaction orotron can occur due to higher-order oscilla-
tion modes simultaneously excited by a beam current much above the starting
level. Here the conditions for excitation of these modes in an open
resonator are established on the basis of the amplitude distribution of
the h-f field along the interaction space. This distribution is first
assumed to be arbitrary and the corresponding nonlinear equation of motion
in the one-dimensional approximation is linearized. The ratios of m,n-
mode to 0,0-mode starting currents and resonator energies are then calcu-
lated in terms of geometrical relations, for an open resonator with spheri-
cal mirrors. The results, fairly well supported by experimental data on
$m = 0,1,2$; $n = 0,1,2$ modes, reveal that with increasing space charge, at
a constant length of the interaction space, the minimum starting current
increases but the ratio of m,n-mode to 0,0-mode starting currents decreases.
Figures 2; references: 4 Russian.
[199-2415]

POWER ENGINEERING

THERMAL CONDITIONS IN SEMICONDUCTOR POWER DEVICES OPERATING IN SINGLE-PULSE MODE

METRIKIN, V. S., NEYMARK, A. Yu. and ORUAAS, Ya. A., Scientific Research
Institute of Applied Mathematics and Cybernetics, Gor'kiy State University
imeni N. I. Lobachevskiy

[Abstract] A mathematical model and an algorithm are constructed for
determining the thermal conditions in an axisymmetric multilayer power
thyrsitor structure with a p-n-p-n semiconductor element containing the
control electrode in the silicon region, and with thermally insulated
lateral surface. All heat is assumed to evolve in the n-base and dissi-
pate either through one side (pin construction) or through both sides (disk
construction). The temperature field produced by a single current pulse
is calculated from the two-dimensional equation of transient heat conduction
in cylindrical coordinates, for appropriate initial and boundary conditions.
The temperature distribution depends on shape and location of the control
electrode, it in turn determines the maximum permissible load and the
cooling requirements. A close agreement is found between results of these
calculations and experimental data on the maximum excess temperature as a
function of time in TB-400 and TB151-50 thyristors with centrally located
circular control electrode and various durations of single breakdown-
current pulses. The paper was recommended by the Department (Kafedra) of
Theoretical Physics. Figures 2; references: 10 Russian.
[202-2415]

USE OF SEMICONDUCTORS FOR CONVERSION OF SOLAR ENERGY

ARUTYUNYAN, V. M., doctor of physical and mathematical sciences,
SARKISYAN, A. G., candidate of technical sciences, and PANOSYAN, Zh. R.,
candidate of physical and mathematical sciences

[Abstract] Approximately 100 solar electrical stations [SES] operate in
the USSR. An experimental base in the Crimea, an industrial SES with a
power of 5000 kW, will be created. In the USSR as far back as 30 years
ago serious attention was paid to the sun as a source of energy. Solar
equipment for heating and for boiling water, its desalting and for obtaining
steam were developed. At present in the USSR installations which use solar
energy are produced and widely used in the national economy. Solar water
heaters find use at agricultural enterprises, sanatoriums, laundries,
bathhouses, etc. "Solar homes" of various designs are constructed in
Uzbekistan, Turkestan, Tajikistan and in the southern Ukraine. In Yerevan,
at the Armyanskiy Heliocenter, construction is completed of installations,
the parabolic mirrors of which produce a temperature in the operating space
of the solar furnace which melts the most difficult to fuse materials.
Solar furnace installations make it possible to synthesize super-pure
materials thanks to the freedom from various substances, inevitable with
other (met llurgical) methods. Soviet scientists have made a great contri-
bution to the development of semiconductor converters of solar energy into
electrical (solar batteries). Creation of effective photoconverters, which
absorb and directly convert into electricity a considerable part of the
energy of the solar rays falling on them, provided a real revolution in
electrical engineering. Our progress in semiconductor photoconverters
came in the cosmos. Wide use of semiconductor solar batteries under terrestial
conditions is retarded because of the very high cost of a kilowatt of in-
stalled power, which amounts today to tens of hundreds of thousands of
rubles for a silicon battery with an efficiency of ~12% and somewhat greater
for a battery of gallium arsenide-aluminum heterophoto elements with an
efficiency which attains the value of ~20%. Technical progress will of
course lead to a considerable reduction of the cost of solar batteries, but
in the immediate future this is possible only because of a reduction of
their efficiency. However, in principle this path is very promising and
merits the most intent attention of researchers. One of the means of
lowering the price of solar electrical energy is the use of electro-chemical
methods of converting solar energy. This plan considers the possibility of
converting solar energy into electro-chemical elements of the regerative
type. An energy diagram of a regenerative electrochemical element is pre-
sented and the method of its functioning is described. The simplicity of
creating the required potential barrier by a simple immersion of the semi-
conductor electrode into an electrolyte (i.e., not requiring creation of
special p-n junctions and antireflecting covers), as well as the possibility
of using inexpensive polycrystalline semiconductor films, among those
produced by ceramic technology, is among the advantages of liquid solar bat-
teries. The problem of accumulation of energy can be successfully solved if
the solar or electrical energy is used for direct decomposition of water into
hydrogen and oxygen. Figures 1.
[157-6415]

QUANTUM ELECTRONICS, ELECTRO-OPTICS

OPTOELECTRONIC DIFFERENTIAL BRIGHTNESS METER

DORINA, V. N., DORIN, V. A. and D'YACHENKO, V. G., Leningrad Polytechnical
Institute imeni M. I. Kalinin

[Abstract] An optoelectronic brightness meter is described, in which an
instrument adjustment for the initial level is introduced. With the aid
of this brightness meter it is possible to measure the difference in blacken-
ing of different sections of a photograph and by means of repeated measure-
ments it is also possible to measure the contrast. At the basis of the in-
struments the principles are placed which were used in a device described
in a 1969 paper of which V. N. Dorina (see above) was the principal author.
The difference is the addition of a clipper of the electrical signal and
the presence of a matching pair of light-emitting diodes--phototransistors.
The read-out spot has an area less than 1 mm^2. The paper was recommended
by the Department (Kafedra) of Experimental Physics. Figures 3;
references: 2 Russian.
[151-6415]

EFFECT OF RANDOM ERRORS ON CHARACTERISTICS OF ACOUSTO-OPTICAL
CORRELATORS OPERATING IN REAL TIME

VODOVATOV, I. A. and ROGOV, S. A., Leningrad Polytechnic Institute

[Abstract] An optical correlator at the output of an acousto-optical
modulator is considered for processing harmonic signals in real time, with
a space filter in the frequency plane which has been produced holographically

from a multichannel reference transparency. The performance of such a
correlator in the first diffraction order is analyzed taking into account
field fluctuations at the system output due to several independent random
effects. Results of calculations for two special cases, a random quantity
with a uniform distribution and with a normal distribution respectively,
indicate that the mean field at the output is determined by phase errors
and by variances of modulator and transparency design parameters, while
the dispersion of the field is determined principally and in the same
manner by phase and amplitude errors. Figures 3; tables 1; references 8:
7 Russian, 1 Western.
[201-2415]

ELIMINATION OF AMBIGUOUS READOUT OF INTERFERENCE GONIOMETERS

KHOROSHEV, M. V., Moscow Institute of Engineers of Geodesy, Aerial
Photography and Cartography

[Abstract] The effect is shown of readout ambiguity on the construction
of interference-type measuring devices. Characteristic special features
of the process of measurement by interference devices are listed. All these
are connected with a solution of the problem of ambiguous readout. A
scheme for a two-channel device is proposed which makes it possible to
eliminate the ambiguity of readout and to expand the range of magnitudes
measured by interference goniometers. A device realized in a number of
modifications at the Department (Kafedra) of Optoelectronic Devices of
the Moscow Institute of Engineers of Geodesy, Aerial Photography and
Cartography makes it possible to perform angular measurements with an
error above 0".1 in the range to 5'. The paper was recommended by the
Department of Optoelectronic Devices.
[151-6415]

ALGORITHM OF SYNTHESIS ON COMPUTER OF DOUBLE-CEMENTED OBJECT

SHEKHONIN, A. A. and RODIONOV, S. A., Leningrad Institute of Precision
Mechanics and Optics

[Abstract] A cemented two-lens objective is one of the most widely dis-
tributed and studied forms of optical systems and consequently its automated
calculation is a necessary component in the synthesis of an automatized
system for designing optics. The present work considers the problem of
developing an automatized synthesis of a cemented doublet with optimum
balancing of all the aberrations in any spectral region with allowance
made for the final magnitude of the visual field and under the condition
of a choice of the best combination of glasses. A chart is shown of the
algorithm of automated synthesis. The results of a calculation of cemented
two-lens objectives on the YeS-1022 computer, using the algorithm, are
given in a table where three versions of the synthesis of optimum construc-
tion are presented. The paper was recommended by the Department (Kafedra)
of Optical Devices. References: 5 Russian.
[151-6415]

STABILITY OF EMISSION PULSES IN LASER WITH PERIODIC LOSS MODULATION

DAUME, E. Ya., Institute of Applied Physics, USSR Academy of Sciences

[Abstract] Unidirectional emission of pulse sequences in a traveling-wave
laser with a two-level active medium having a uniformly widened amplifica-
tion line and with periodic modulation of losses in the resonator cavity
is analyzed for stability. The emission pulses are assumed to be identi-
cal and to have a quasi-Gaussian form negligibly affected by saturation
and by changes in the population difference but significantly affected by
gain dispersion. The modulator is a lumped element which varies the jump
of amplitude of the electric field intensity at its location, this action
being equivalent to multiplication of the input signal by some periodic
function of time. The equations for the electric field of a linearly
polarized plane wave, for the polarization of the active medium, and for
the population difference in the laser are solved in dimensionless coordinates
for a single circulation inside the resonator cavity. An analysis of the

quasi-periodic solution for the steady state reveals that a pulse formed during a modulator transmission peak will be stable, while pulses leading or lagging the maximum will be unstable on account of departure from the Gaussian approximation in the cases of very short circulation time or very short polarization relaxation time. The author thanks V. I. Bespalov for formulating the problem and discussing the results. Figures 3; references 10: 4 Russian, 6 Western.
[201-2415]

QUALITY OF PANORAMOGRAM PHOTOGRAPHY OF NATURAL SCENES FOR HOLOGRAPHIC CINEMATOGRAPHY

IGNAT'YEV, N. K., KOSODUROV, S. I. and FEDCHUK, I. U., All-Union Scientific Research Motion Picture Institute

[Abstract] An analytical investigation is made of the scattering function of a line of parallax-panoramograms in a horizontal plane. The following items are considered: 1) Basic parameters of photography and reproduction; 2) Scattering function of line; and 3) Transverse resolution and depth of space reproduced. The following are presented in figures: 1) Equivalent optical circuit of a parallax-panoramogram and the optical circuit of a system of raster-carrier of photoeffect; 2) Determination of the transverse resolution of a light line; 3) Curve of change of width of scattering function of line; and 4) Example of curve of transverse resolution of parallax-panoramogram. It is shown that: 1) The scattering function of the line of a parallax-panoramogram is determined on the basis of a consideration of the optical circuit for formation of an image behind the lens of the raster and the scheme of its observation by the eye; 2) The characteristics are obtained of the transverse resolution of a parallax-panoramogram as a function of the depth of the image being reproduced. As an example, the characteristics are sufficiently close to the actual; and 3) The characteristics of the resolution are asymmetrical with reference to the plane of the raster and are more restricted from the side of the observer.
Figures 4; references: 2 Russian.
[159-6415]

SOLID STATE CIRCUITS

PULSE PHOTOELECTRIC CURRENT IN ORGANIC SEMICONDUCTOR LAYERS QUASI-
HOMOGENEOUS WITH RESPECT TO THICKNESS OF CARRIER GENERATION

GAYLIS, A. K. and KOLESNIKOV, V. A., Physics and Power Engineering Institute,
LaSSR Academy of Sciences

[Abstract] An analysis is made of a photoelectric pulse current as a function
of the intensity of the exciting light. The following points are considered:
1) Effect of level of generation of charge carriers on pulse photoelectric
current; 2) Pulse photoelectric current with inhomogeneity of carrier genera-
tion with respect to thickness of specimen; and 3) Discussion of experimental
results. The dependence of the pulse photoelectric current in oriented
layers of pentacene L = 1.75 micrometer thick on the intensity of the inci-
dent light was measured. The area of the specimen was 10 mm^2. A LTIPCh-5
laser with a modulated Q and a wavelength λ = 0.53 micrometer served as the
source of radiation. Measurements were made at room temperature in a
nitrogen atmosphere. The intensity of the incident radiation was varied by
neutral filters. The measurement were made a number of voltages on the
specimens from 1 to 10 V. The authors thank E. A. Silin'sh for valuable
council during discussions. Figures 3; references 9: 7 Russian, 2 Western
(1 in translation).
[177-6415]

147

LIMITING CHARACTERISTICS OF GaAs INTEGRATED CIRCUITS WITH FIELD-EFFECT
TRANSISTORS

STAROSEL'SKIY, V. I. and SAPEL'NIKOV, A. N., Moscow Institute of Electronic
Engineering

[Abstract] Field-effect transistors with Schottky gate or heterojunction
are considered for logic circuits, normally-closed devices having excellent
energy characteristics but requiring very thin (0.1 micrometer) highly
homogeneous GaAs layers and normally-open devices offering a higher response
speed with thicker (0.2 μm) GaAs layers. Further improvement in both energy
and speed characteristics requires a technology which takes into account
the fact that charge accumulation in the subgate region decreases with
decreasing gate length, that ohmic resistance of contacts and in passive
source and drain regions decreases the slope of the current-voltage charac-
teristic while increasing the residual voltage and the power drain, and that
the gate-channel capacitance is proportional to the linear dimensions of
elements squared. A comparative evaluation of the main parameters, based
on piecewise-linear approximation of the current-voltage characteristic
and on model topology of the respective structures, indicates that normally-
open field-effect transistors with Schottky gate are preferable on account
of their highest operating speed. Normally-closed devices should be con-
sidered only when a technology for producing sufficiently short gates
(0.2-0.5 micrometer) is available or where the energy requirements are
overriding. Parasitic resistance can be minimized by additional doping
of contact regions and by fabrication of gates by method of self-matching.
Figures 8; references 10: 1 Russian, 9 Western.
[250-2415]

THEORY OF LIGHT DIFFRACTION BY ULTRASOUND WAVE

ZIL'BERMAN, G. Ye., SIDOROV, I. N. and KUPCHENKO, L. F.

[Abstract] The theory of light diffraction by a moving grating formed by
a sound wave propagating through an isotropic homogeneous medium involves
solution of the appropriate Raman-Nath equations for a wide range of inter-
action angles. These equations of light diffraction by ultrasound waves
follow from the wave equation for the electric field of a light wave. Most
important are the solutions to these equations for integral values of the
parameter $z = \sin\theta/\sin\theta_B$ (θ- interaction angle, θ_B- Bragg angle). The solu-
tions for an even z can be reduced to the z = 0 case and the solutions for
an odd z can be reduced to the z = 1 case. An examination of these solu-
tions and their properties reveals higher-order Bragg reflections. Experi-
mental detection of second-order, third-order, and higher-order Bragg reflec-
tions requires determining the widths of the corresponding resonance curves,
i.e., of the successively narrower intervals of interaction angle within
which the corresponding diffraction components are sufficiently strong.
The critical angle in each case must then be approached within a successivelt
narrower tolerance. Figures 1; references 10: 6 Russian, 4 Western.
[199-2415]

INTEGRATED ACOUSTO-OPTICAL CELL WITH THIN-FILM PRISM FOR SURFACE
ACOUSTIC WAVES

AKSENOV, Ye. T., KOZLOV, K. V., KUKHAREV, A. V., LIPOVSKIY, A. A.,
PAVLENKO, A. V. and SANIN, K. V., Leningrad Polytechnical Institute
imeni M. I. Kalinin

[Abstract] Thin metal films on piezoelectric substrates can serve as
simple devices for controlling the phase and the direction of propagation
of surface acoustic waves excited in a pair of acousto-optical cells. The
feasibility of using a thin-film prism on one of two integrated cells is
established in an experimental study. A pair of piezoelectric transducer
cells with center frequencies 165, 220 MHz and apertures 2.2, 1.7 mm,
respectively, each of interdigital construction, are tested with a GaP
prism (0.17 mm x 2.21 mm, angle 4.34°) before the 165 MHz cell. The de-
vice was built by the photolithographic process, with a 100 nm thick
aluminum film on a Y-cut $LiNbO_3$ crystal substrate in which an optical
waveguide had been formed by diffusion from a 40 nm thick titantium film
in air. Subsequent measurements with the TE_0-TE_0 mode of $\lambda = 0.63$ μm
light constant 8 V voltage amplitude reveal a 100 MHz wide band of opto-
acoustic diffraction without adjustment of the angle of incidence of light,
with the maximum efficiency (amplitude) of 92% at 235 MHz and 400 mW input
power, in contrast to the sharp resonance peaks at respective center
frequencies when the two cells are excited separately. Figures 2;
references 6: 3 Russian, 3 Western.
[250-2415]

QUASI-UNIDIMENSIONAL ORGANIC METALS

LAUKHIN, V. N. and SHCHEGOLEV, I. F., Institute of Chemical Physics,
USSR Academy of Sciences

[Abstract] A survey is made of the physical properties of high-conducting
quasi-unidimensional organic metals. All the organic metals known at
present may, perhaps, be divided into three groups, two of which are con-
sidered in some detail in the present paper. Problems of stabilization
of the metallic state at low temperatures are discussed. The authors
thank E. B. Yagubskiy for much assistance during preparation of the materials
for the work. Figures 7; tables 2; references 40: 16 Russian, 24 Western.
[177-6415]

CALCULATION OF QUASI-PERIODIC PROCESSES IN NONAUTONOMOUS JOSEPHSON JUNCTION

GUSEV, A. V. and RUDENKO, V. N.

[Abstract] The response of a Josephson junction to a weak quasi-harmonic
signal is calculated on the basis of the resistive low-capacitance model of
a superconducting point contact. A general expression for the low-fre-
quency slow voltage component across a nonautonomous Josephson junction is
derived by the method of averaging with quasi-linearization, through re-
duction of the model equation to standard form by a change of variables.
Results obtained by this method are more accurate than those by the method
of small perturbations and by the Poincare method, they are also applicable
not only in the resonance band but also far away from it and in the

transition range of beats. The authors thank V. V. Migulin, V. B. Braginskiy and I. I. Minakova for helpful discussions and comments. References: 8 Russian.
[199-2415]

EFFECT OF BACKGROUND RADIATION ON JOSEPHSON DETECTOR CHARACTERISTICS

IL'IN, V. A., SHURMINOVA, T. M. and ETKIN, V. S.

[Abstract] An experimental investigation is made of the effect of background radiation on the characteristics of a Josephson detector and the radiometer with such a detector in a wide band T_f, which corresponds to the conditions of real radio astronomical reception on Earth and in cosmic space. A block diagram is presented of a unit used for study of the sensitivity of detectors, and the technique of the experiment is explained. The authors conclude that the sensitivity of Josephson detectors and the radiometers on their basis significantly depends on the noise temperature coming into contact with background radiation. The reduction of it in magnitude as compared with the contact temperature significantly improves the sensitivity of the detector. Use of a matched load cooled to T = 4.2 K makes it possible to investigate a superconducting point contact [SPC] under conditions of real radio astronomy reception on Earth ($T_f \sim$ 60 K) and in cosmic space ($T_f \sim$ 10 K). In order to obtain a further increase of the sensitivity of the detectors based on Josephson SPC, an improvement of the matched contact with the supply channel and expansion of the detector band is necessary as well as a decrease of the noise of the low-frequency part of the radiometer. The authors thank Ye. M. Gershenzon, V. P. Zavaleyev, L. S. Kuz'min and K. K. Likharev for fruitful discussions. Figures 4; references 9: 8 Russian, 1 Western.
[88-6415]

SOME PROBLEMS IN CONTEMPORARY THEORY OF LOW-DIMENSIONAL ORGANIC METALS

OVCHINNIKOV, A. A. and KRIVNOV, V. Ya., Scientific-Research Physico-
Chemical Institute imeni L. Ya. Karpov

[Abstract] The present work is concerned with organic complexes with
charge transfer, synthesized in recent years. Such complexes are molecular
crystals which consist of the plane molecules of acceptors (A) and donors
(D). The characteristic special feature of such systems is the pronounced
anisotropy of their properties, the reason for which involves the distinctive
stack packing of the molecules in these crystals. At the same time con-
ductivity in directions perpendicular to the stacks, by virtue of which
these crystals are essentially quasi-one dimensional. In the structure
the relation of the complexes mentioned can be divided into two classes.
Crystals which consist of displaced stacks in which A and D alternate
pertain to Class I; Class II consists of separate alternating stacks of
A and D. Typical representations of Class I are complexes of TTF-chloranil
and others; of Class II--TTF TCNQ, NMP-TONQ, complexes of platinum of
mixed valence $K_2Pt(CH)_4Br_{0.3} \cdot 3H_2O$ and others. The highly-conducting
systems--organic metals pertain as a rule to Class II; systems of Class I
are typical semiconductors with a relatively low magnitude of conductivity.
Other problems in contemporary theory of low-dimensional organic metals
are also discussed. The electronic structure for a number of charge carrier
complexes are studied and their correlation functions calculated. Figures 3;
references 23: 11 Russian, 12 Western.
[177-6415]

ANOMALOUS GROWTH OF OXIDE ON SILICON AT LOW OXYGEN PRESSURES

FRANTSUZOV, A. A., KOVCHAVTSEV, A. P., MAKRUSHIN, N. I. and
SOKOLOV, R. A., Institute of Physics of Semiconductors, Siberian Division,
USSR Academy of Sciences

[Abstract] The results are given of a study of the reproducible production
of hyperfine oxide films on a silicon surface. With sufficiently low oxygen
pressures and sufficiently high temperatures the process of the oxidation
of silicon is replaced by etching of the silicon. A study is made here of
oxidation in the critical region adjoining the etching region. The

experiment was conducted in a vacuum chamber making it possible to achieve pressure of below 10^{-9} mm Hg. The silicon specimen was heated by passing current directly through it and the surface was cleaned by repeated oxidation and annealing to the oxide's vaporization temperature, after which the specimen was cooled, oxygen was let into the chamber to a specific pressure and the temperature of the specimen was raised to the chosen amount and exposure to the oxygen took place for a few minutes. The amount of oxide grown during exposure was determined by a mass spectrometer or by the scintillation method or with an ellipsometer. Volt-farad characteristics and conduction with a variable signal were measured after applying gold contacts 100 microns in diameter. These measurements made it possible to monitor the charge state of the silicon-oxide interface and the dielectric properties of the oxide. The results demonstrate that when the temperature rises above a certain critical value anomalies originate both in the kinetics of growth and vaporization and in the properties of the oxide and interface. A transition region of the growth of an anomalous oxide occurs between the regions of the growth of a normal oxide and of etching of the silicon surface by the oxygen, and this transition region occurs at temperatures of 900 to 1100 °C with a drop in the oxygen pressure below the critical value of 10^{-4} and 0.5 mm Hg, respectively. The anomalous oxide consists of two phases, the first of which vaporizes easily at temperatures above 1000 °C and the second of which does not vaporize even at 1200 °C. The anomalous oxide film differs in composition from SiO_2 and its dielectric constant can vary from 4 to 6. There is an increase in porosity of the oxide, the rate of surface generation, the depth of the spatial distribution of traps in the surface layer of the oxide and in the positive embedded charge in the oxide. A sufficiently high oxygen pressure must be maintained in order to suppress the process of the growth of an anomalous oxide. Figures 2; references 14: 5 Russian, 9 Western.
[210-8831]

PROBLEMS OF SEARCH FOR STRONG ORGANIC ELECTRON DEVICES AND ELECTRON ACCEPTORS AND THEIR PHYSICO-CHEMICAL PROPERTIES

NEYLAND, O. Ya., Riga Polytechnical Institute

[Abstract] Using generalized data from the literature, a number of organic compounds are considered with respect to their individual classes and their individual classes and their ionization potential [IP] or electron affinities [EA], with an indication of the shortcomings of these compounds as strong donors or acceptors, and on possible means of search. Possible ways for their synthesis are considered. The structural formulas of organic compounds are presented. Under the formulas the number of the formula and the IP or

EA are given in e.V. In the opinion of the authors, during a search for new donors and acceptors it is necessary to focus on a solution of the following problems: 1) Use of quantum-chemical calculations of ion radicals for the characteristics of delocalization of an unpaired electron in front orbits with the object of revealing the effect of change of the chemical structure; 2) Synthesis of new neutral donors with an IP of 6.2-7.0 eV, varying structure and symmetry, and search for donors in the unknown region IP < 6.1-6.2 e.V., forming cation radicals resistant to chemical action and dimerization; 3) Synthesis of aniomic donors with IP < 2.2-2.5 eV., forming stable radicals; 4) Synthesis of new neutral acceptors with an EA of 2.0-3.2 e.V., a varying structure and symmetry, search for new "superstrong" acceptors with EA < 3.2 e.V., forming stable anionic-radicals; and 5) Synthesis of conjugated cations with EA > 6.2 E.v., forming stable radicals. The author thanks V. E. Kampar for fertile discussions and for assigning the data of quantum-chemical calculations. Figures 4; tables 1; references 42: 28 Russian, 14 Western.
[177-6415]

CSO: 1860   - END -

155